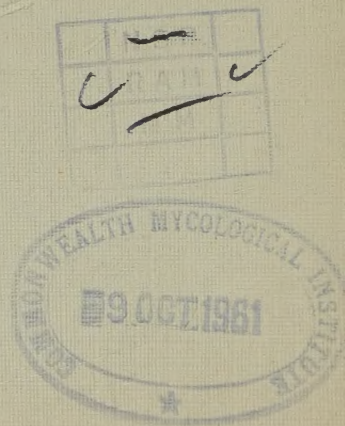


UNITED PLANTERS' ASSOCIATION OF
SOUTHERN INDIA

SCIENTIFIC DEPARTMENT
(TEA SECTION)

ANNUAL
ADMINISTRATION REPORT
FOR
1960 - 1961



NOTE:

Specimens for laboratory examination should be sent by *unregistered* post to

The Officer-in-Charge,
UPASI Tea Experiment Station,
Devarshola P. O.,
Nilgiris.

In the case of specimens too bulky to send by post, they should be sent by rail to Ootacamund and the Rail Receipts or parcel Way Bills sent to

The Rajalakshmi Motor Service,
Ootacamund.

for collection and forwarding to Devarshola.

UNITED PLANTERS' ASSOCIATION OF
SOUTHERN INDIA

SCIENTIFIC DEPARTMENT
(TEA SECTION)

ANNUAL
ADMINISTRATION REPORT
FOR
1960 - 1961

TEA PRODUCT SUB-COMMITTEE

(Up to August 1960)

MR. C. STEWART	<i>Chairman - Resigned December 1959</i>
MR. J. R. HENSHAW	<i>Chairman - From December 1959</i>
MR. C. H. S. LONDON	<i>Member</i>
MR. W. WILSON MAYNE	<i>(President, UPASI) Ex-Officio</i>
MR. M. M. VARGHESE	<i>(Vice-President, UPASI) Ex-Officio</i>

TEA PRODUCT SUB-COMMITTEE

(From September 1960)

MR. J. R. HENSHAW	<i>Chairman</i>
MR. C. H. S. LONDON	<i>Member (Chairman - from December 1960 to May 1961)</i>
MR. C. V. SUBBU	<i>Member</i>
MR. H. C. KOTHARI	<i>(President, UPASI) Ex-Officio</i>
MR. W. WILSON MAYNE	<i>(Vice-President, UPASI) Ex-Officio</i>
	<i>(Up to February 1961)</i>
MR. W. C. F. SIMMONDS	<i>(Vice-President, UPASI) Ex-Officio</i>
	<i>(From March 1961)</i>

AD-HOC RESEARCH EXPANSION SUB-COMMITTEE

(From September 1960)

All Members of the Tea Product Sub-Committee and

MR. P. W. DAVIDAR	<i>Member</i>
MR. E. J. C. MENZIES	<i>Member</i>
MR. J. W. THOMAS	<i>Member</i>
CHAIRMAN, TEA BOARD	<i>Member</i>

SCIENTIFIC DEPARTMENT

TECHNICAL STAFF

MR. S. ANANDA RAU, M.Sc.	<i>Chief Scientific Officer</i>
MR. V. JAYARAMAN, B.A., B.Sc. (Ag.)	<i>Soil Chemist</i>
DR. K. S. VENKATARAMANI, M.Sc.	<i>Botanist</i>
Ph.D., F.B.S.	
DR. C. S. VENKATARAM, M.Sc., Ph.D.	<i>Plant Pathologist</i>
MR. N. R. ANANTHAKRISHNAN, B.Sc.	<i>Entomologist</i>
(Hons.) Ag., A.I.A.R.I.	
MR. T. N. RAMAKRISHNAN, M.Sc.	<i>Asst. Soil Chemist (From April 1961)</i>

OFFICE STAFF

MR. K. I. ABRAHAM	<i>Clerk—Devarashola</i>
MR. S. KAILASANATHAN	<i>Clerk—Coonoor</i>
MR. M. MARIADAS	<i>Attender—Coonoor</i>

FIELD STAFF

MR. E. POWELL	<i>Field Recorder</i>
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LABORATORY ATTENDERS

MR. P. SANKARAN NAIR
MR. K. MADHAVAN CHETTY
MR. AHMED KUTTY

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United Planters' Association of Southern India

ANNUAL REPORT OF THE UPASI SCIENTIFIC DEPARTMENT

TEA SECTION

For 1st April 1960—31st March 1961

REPORT OF THE CHIEF SCIENTIFIC OFFICER

PART I—ADMINISTRATION

The Chief Scientific Officer continued to have his office at "Glenview", Coonoor, and the Soil Chemist was in day-to-day charge of the Tea Experiment Station, Devarshola.

The Botanist and Plant Pathologist were stationed at Devarshola, but the Entomologist continued to work in Central Travancore, having his residence at Arnakal Estate, Vandiperiyar, through the courtesy of Messrs. A. V. Thomas & Co. Ltd.

The Agronomist's post was not filled during the year mainly due to lack of accommodation and would probably remain so until buildings are constructed in the new Central Station and Sub-Station.

There were no staff changes during the year, but towards the close of the year, arrangements were taken on hand to transfer the Botanist to Coonoor in order to intensify the work of selection and multiplication of clonal material and to appoint an Assistant to the Soil Chemist with a view to relieve the latter of much of the routine work of soil and fertiliser analyses involved in advisory work. Mr. T. N. Ramakrishnan, M. Sc., appointed as Assistant Soil Chemist, joined duty at Devarshola at the beginning of April 1961 and the Botanist moved to Coonoor in the middle of the same month.

Tea Experiment Station, Devarshola : The Station was maintained on an almost care and maintenance basis. With the prospect of a move to the Anamallais, no additions or alterations were made to the Station buildings.

The tea areas of the Station received the usual attention. The year started well with satisfactory rain received in April / May and a steady crop was maintained until the end of November, 1960. The period December 1960 to March 1961 was very dry, rain falling on only 4 days during this 4-month period, the total quantity of rain received being only 37 mm. This was too small to be useful to tea. The year ended with a total rainfall of 1721 mm. as against 2174 mm. in 1959-60.

Despite the lower rainfall, the 5.29 hectares of tea in bearing yielded 36,788 kg. green leaf for the year as against 32,102 kg. in the previous year, this increase of 4686 kg. representing an increase of 886 kg. green leaf per hectare. The yield for the year in terms of made tea, assuming an average outturn of 23%, was 1611 kg. per hectare as against 1402 kg./hectare in 1959-60. By the sale of the year's crop as green leaf at 28 nP. per lb. (61.6 nP. per kg.), a sum of Rs. 22,661.24 nP. was realised.

The monthly distribution of crop during the year was as follows :—

MONTHLY CROP STATEMENT

		Kg./green leaf	Average for past 5 years Kg./green leaf
April	1960	3,519	1,618
May	"	3,557	2,928
June	"	3,117	3,126
July	"	4,474	3,780
August	"	3,081	3,572
September	"	4,234	4,122
October	"	3,357	4,276
November	"	4,110	4,185
December	"	2,310	2,566
January	1961	2,316	2,117
February	"	1,443	1,233
March	"	1,270	1,221
		36,788	34,744

In order to give an idea of the extent to which yields vary as the result of different plant materials used and differing experimental treatments imposed during the course of over 30 years, a statement of the monthly field yields for 1960-61 for the various fields is given below :—

MONTHLY FIELD YIELDS FOR 1960 - 61

(in kg./hectare)

Field Nos: Area (in hectare)	1926 (1 11)	1927 (0.37)	1928 (0.53)	1929 (0.36)	1930 (0.96)	Contour (0.63)	Old Tea (1 21)
1960:							
April	577.1	—	398.9	1112.5	585.4	1141.7	864.6
May	926.1	—	—	920.9	877.2	822.3	680.2
June	681.9	116.8	103.4	739.2	584.5	817.9	744.8
July	1089.1	163.2	214.5	1096.4	807.5	1133.8	978.5
August	820.3	350.6	322.2	688.1	559.6	806.4	539.8
September	834.1	628.2	537.6	784.0	668.2	1086.7	934.1
October	714.3	707.3	870.1	395.7	625.0	718.3	561.9
November	718.8	781.5	1030.0	825.1	722.9	1349.8	526.1
December	380.0	645.2	831.4	507.7	299.7	338.1	431.2
1961:							
January	620.7	547.8	769.4	501.5	322.3	570.1	165.4
February	241.5	269.0	311.9	377.1	150.6	607.7	172.8
March	239.1	359.2	323.9	197.9	194.3	561.5	72.8
	7843.0	4568.8	5713.3	8146.1	6397.2	9954.3	6672.2
Made Tea (in kg./hectare)	1804	1051	1314	1874	1472	2289	1534

Correspondence: Unlike in 1959-60, the correspondence dealt with at the Devarshola Station showed a substantial increase during the year under report and the number of technical enquires was also greater. The volume of correspondence and technical enquiries handled by the Chief Scientific Officer was overwhelmingly large in comparison with previous years and may soon call for serious notice being taken of it in order adequately to cope with the situation.

Publications : During the year under report, the scientific staff of the Department prepared a total number of 17 research papers. Two were published in scientific journals, two have been accepted for publication, ten are included in the Appendix to this report and the remaining three are awaiting final processing before publication. The papers cover various aspects, such as vegetative propagation, control of blister blight, studies on mites and their control, bud-break in tea and weedkillers. The titles of these articles are given in the reports of individual officers which follow.

A new feature introduced during the year was the publication of short notes on current problems in the "*Planters' Chronicle*". These notes were published periodically in six issues of the journal.

In addition, articles on tea were also contributed to the planting supplements brought out by newspapers on the occasion of the UPASI Annual Conference.

Touring : The touring of planting districts was not a prominent feature of the year, but estates were visited whenever called upon to do so. The details of touring done by the Chief Scientific Officer are given below :

April	1960	...	Thiashola Estate, Nilgiris.
May	"	...	...
June	"	...	Ootacamund (to attend meeting of Nilgiri District Soil Conservation Board).
July	"	...	Kodanaad Estate, Nilgiris.
August	"	...	Anamallais. Daverashola, Mayfield and Woodbriar Estates, Nilgiri - Wynaad. Nonsuch and Ben Gorm Estates, Nilgiris.
September	"	...	Korakundah Estate, Nilgiris. Central Travancore. Nonsuch Estate, Nilgiris.
October	"	...	Delhi (to attend the UNESCO Symposium on Termites).
November	"	...	Thiashola Estate, Nilgiris.
December	"	...	Anamallais.
January	1961	...	Ceylon (to attend the Conference of the Tea Research Institute of Ceylon). Calcutta (to attend the meeting of the Tea Research Liaison Committee of the Tea Board).

February 1961 ... Sutton Estate, Nilgiris.

March " ... Central Travancore.
Delhi (to attend meeting organised by the Council
of Scientific and Industrial Research).

Periodical visits, as usual, were made to the Tea Experiment Station, Devarshola.

The other officers of the Department also undertook a few tours and the details of touring done by them are given in their respective reports.

UPASI Exhibition : Consequent on the decision to hold the exhibition every other year, there was no exhibition in 1960.

VIII Annual Scientific Conference : This Conference which is normally held in March every year could not be arranged in March 1961, as difficulty was experienced in fitting in a full day for the Conference at the time of the budget meetings. It was accordingly postponed to be held during UPASI Conference Week in September.

Research Expansion Scheme : It was at long last possible to make a beginning this year with the construction of the Laboratory in the Anamallais. The foundation stone was laid by the Hon'ble Shri Nityanand Kanungo, Union Minister of Commerce, on 29th December 1960 and by the end of March 1961, the construction had progressed up to the first floor level. Considerable difficulty is being experienced in obtaining the requirements of cement and steel and provided supplies of these materials became available in time, it is hoped that the Laboratory construction will be completed before March 1962.

As regards staff quarters, in view of the rising costs of building materials since the original estimates made several years ago, it became clear that the cost cannot be kept within the estimates sanctioned by Government. Plans have therefore been revised to permit of this being done and quantity estimates were under preparation for taking tender action.

The above remarks apply also to the buildings proposed to be erected in the Central Travancore Sub-Station. It is expected to start building construction work of this Station in October / November 1961 after the South-West monsoon rains are over.

Boards, Committees and Conferences : The Chief Scientific Officer was the nominee of the UPASI on the following Boards and Committees :—

1. Board of Agriculture and Animal Husbandry in India - Crops and Soils Wing of the Indian Council of Agricultural Research.

2. The Nilgiri District Soil Conservation Board.
3. Tea Research Liaison Committee of the Tea Board.
4. Agriculture and Food Products Division Council of the Indian Standards Institution (alternative to I. T. A. representative).
5. Pest Control Products Sectional Committee of the Indian Standards Institution (up to June 1960).
6. Acids and Fertilisers Sectional Committee of the Indian Standards Institution.

One meeting of the Tea Research Liaison Committee of the Tea Board and one meeting of the Nilgiri District Soil Conservation Board were attended. It was not possible to attend any of the meetings convened by the Indian Council of Agricultural Research and the Indian Standards Institution.

The Chief Scientific Officer attended the Biennial Conference of the Tea Research Institute of Ceylon held in Colombo in January 1961 and the Botanist attended the Tocklai Conference in November 1960.

The Chief Scientific Officer also participated in the Symposium on "Termites in Humid Tropics" organised jointly by UNESCO and the Zoological Survey of India and held in Delhi in November 1960. During the session, he was asked to serve on a Committee set up to examine one aspect of the subject, viz., control of termites in agricultural crops and forests and to make a report for consideration at the final plenary session.

The Botanist was deputed to serve on a Committee set up by the Coffee Board to survey and advise on the problem of die-back of arabica coffee which had caused great concern to coffee estates in Coorg and Mysore.

The Plant Pathologist attended the Tenth Anniversary of the Fulbright Programme of the U. S. Educational Foundation in India held in Delhi in November 1960. He presided over the section of Botany and contributed a paper to one of the technical sessions.

Tea Board Research Liaison Committee : The various research schemes sponsored by the Tea Board continued to function except the scheme on *Helopeltis* undertaken by the Calcutta University which was terminated. No fresh schemes were undertaken during the year under report.

Visitors : We were pleased to welcome during the year the following overseas visitors at Coonoor and/or Devārshola:

Dr. Gruner of the International Potash Institute, Switzerland, Mr. A. J. Brink of Dow Chemical International, Hong Kong, Mr. J. G. deGeus of the Central Nitrogen Sales Organisation, Holland, Mr. J. S. Frazer of the D. S. I. R. Laboratory of the Government Chemist, England, Mr. F. H. Kehl of the Tea Research Institute of Ceylon, Dr. Charles E. Staff of Union Carbide, New York, Dr. Otto Kohnke, Director, Agricultural Overseas Service, Hannover, Germany, Dr. Paul M. G. Tag of Ruhr-Stickstoff, Germany, and the Iranian Tea delegation led by Mr. M. Mansoury, Director General, Tea Organization, Teheran.

Representatives of commercial organisations associated with planting called on us from time to time and contacts with them were of great value as they provided an opportunity to keep ourselves up to date with information concerning the supply position of various plant protection formulations, both old and new, equipments, fertilisers, etc.

We were also pleased to receive during the year Mr. Lampitt, Scientific Officer of the Assam Tea Co. Ltd. and Mr. Fazlullah Khan, Spices Development Officer, Government of India.

Finally, it was a great pleasure to me and to my colleagues at Devarshola to welcome Mr. J. R. Henshaw, Chairman, UPASI Tea Product Sub-Committee, who paid a visit to the Tea Experiment Station during the year.

PART II—RESEARCH AND ADVISORY

The year under report witnessed a sudden spurt in the number of technical enquiries from estates and the volume of advisory correspondence handled during the year was indeed considerable. Enquiries relating to plant protection formulations formed the large bulk of correspondence and requests for analysis of soils and manures were also prominent.

The screening of new fungicides against blister blight which has become a routine feature in the blister blight season every year was carried out during the current year also. It is gratifying to record here that the South African Bureau of Standards evinced great interest in the technique evolved in our Laboratory for the evaluation of fungicides.

Soils: Soils from poor tea areas have continued to be received with a request for their analysis in order to determine the cause of the poor growth of tea. As pointed out by the Soil Chemist, routine soil analysis is not likely to provide any clue, as several other factors, besides soil, are involved. We have no precise information on the limits of plant nutrients below which deficiency occurs and much analytical work on soils from the different tea growing areas must be carried out for a proper elucidation of the problem.

Arising from reports emanating from Ceylon, fears were often expressed that with the continued use of copper fungicides, heavy accumulations of copper may occur in the soil to the detriment of tea. The situation is being examined, though it seems most improbable that this will occur. Coffee in South India which has used considerably larger quantities of copper fungicides than tea and for a much longer period has not so far reported any adverse effect arising out of the build-up of copper in the soil.

Manuring : Interest on this subject has continued unabated, but our recommendations on manuring have not undergone any change during the past few years, as no fresh information justifying a change has come to light either from our own experiments or from those of other tea research stations. A new field trial was started during the year to compare the efficiencies of different sources of nitrogen, namely, ammonium sulphate, ammonium sulphate nitrate, calcium ammonium nitrate, chilean nitrate of soda and urea, but it will be some years before any valid conclusions can be drawn from this trial.

The question of using superphosphate in place of rock phosphate was frequently raised during the year, for the ostensible reason that certain tea soils in South India are not sufficiently acid and superphosphate may therefore be used with advantage. This Department has so far found no valid reason for this change, but is nevertheless currently engaged in a thorough re-examination of the pH status of soils of all the tea growing areas of South India.

Enquiries are frequently received asking whether soils of very high acidity would benefit by the application of lime. Although tea is said to be tolerant of high acidity, it does not seem improbable that in some cases of high soil acidity, application of lime would actually be beneficial. In practice, however, the quantities of lime required to alter or to bring down the acidity are so high, depending on the texture of the soil and its organic matter content, that it will be definitely uneconomic to apply quantities arrived at by theoretical calculation which may be as much as several tons. In the case of exceptionally highly acid soils, we recommend as an experimental measure application of 10-15 cwts. of lime per acre once in 3 years in order to arrest the rise in acidity as a result of continuous high level applications of sulphate of ammonia which has become common practice in Nilgiris. The need for acidic soils for satisfactory growth of tea has been established; even so, there is probably reason to regard this need as a physiological adaptation rather than a real necessity.

Placement of fertilisers has remained a vexed question, one school holding the view that broadcasting should do even in the case of fertiliser mixtures. On theoretical grounds and in the absence of critical experimental data, we still consider that, while broadcasting should suffice in the case of straight nitrogenous fertilisers, mixtures containing phosphoric acid and potash should be placed at feeding root depth.

Blister Blight: Five new organic fungicides were subjected to field trial during the 1960 blister blight season and, as was the experience in previous years' trials, none of them proved satisfactory. It was interesting to note that nickel chloride gave surprisingly good results in the control of blister blight. The trials indicated that nickel at half the strength of copper normally employed was more effective than copper as a fungicide. It was further demonstrable that nickel had an eradicant effect in addition to being protective and could arrest the development of blisters even after infection had taken place. Full details of the trial carried out with nickel compounds are given in the Plant Pathologist's report and in an article on the subject appearing in the Appendix.

With the aquisition of a sun-shine recorder, the posibility of using sun-shine records for predicting blister blight intensity with a view to minimising the number of spraying rounds was examined. Preliminary observations made by the Plant Pathologist do not seem to offer much encouragement to hope that, under the climatic conditions generally obtaining in South India, much use could be made of sun-shine hours for adjusting spraying operations. Studies on the subject are still continuing and we hope to be able to make a full report of our observations next year.

It was pointed out in our last Annual Report that when employing certain copper fungicides, the spraying rounds could conveniently be extended to 14 days without running the risk of control breaking down. A further field trial undertaken in the South-West monsoon period of 1960 has indicated that, from the point of view of crop, while no sizeable difference was noted between 7-and 10-day rounds, the 14-day round was definitely uneconomic.

Diplodia Disease: Further work carried out during the year on this disease established the pathogenicity of this fungus, but it is still not clearly understood how infection takes place under field conditions when the fungus is not normally resident in the soil.

Root Disease: The control of root diseases in tea is of great importance, particularly to some tea estates in Mysore who have evinced keen interest in it. Due to late receipt of supplies of Vapam, the contemplated trials with this product could not be undertaken in 1960, but have been laid out in the early months of 1961.

Growth Studies: The trend of formation of banjis was followed over a period of 5 months on 6 individual bushes selected for vegetative propagation and the results seem to suggest that banji formation, besides being seasonal, is also influenced by the inherent (genetic) characteristic of the bush.

Bud Break on Pruned Tea : A critical trial conducted during the year with different bark washes revealed that caustic soda and lime wash were definitely better than other treatments and that between the two, caustic soda was superior. Even in the absence of moss and lichen, it was found that the two washes definitely assisted bud-break.

Vegetative Propagation : Work on vegetative propagation was intensified during the year and the studies made on this subject have brought out a number of interesting points, as will be seen in the Botanist's report and in the several papers appearing in the Appendix. For example, the nature of the soil used as rooting medium and its pH, hormonal treatments, juvenility of cuttings, carbohydrate reserves and light intensity have all been found to have a significant influence on rooting and growth of cuttings. Further trials have confirmed that treatment with indolebutyric acid (IBA) results in quicker and heavier rooting and that a combination of IBA and naphthalene acetic acid (NAA) produces a synergistic effect. The beneficial effects of incorporating sucrose in these treatments and of soil application of aluminium sulphate are also demonstrated.

A few promising clones combining both yield and quality have been selected at the Experiment Station and several more selections are likely to be made in the near future consequent on the transfer of the Botanist to Coonoor exclusively for this work.

Weedkillers : A few trials with herbicides, both in pots and in the field, were undertaken during the year, the full details of which are given in the Botanist's report. It may be of interest to mention here that young tea seedlings are very sensitive to triazine compounds (Simazine and Atrazine) that these chemicals are phytotoxic if their concentration in the soil exceeds 4 p.p.m.

Mites : Almost whole time attention of the Entomologist was devoted to the study of the biology and seasonal history of mites and of their control. Field trials were carried out with a large number of acaricides against all the three species prevalent in South India, namely, Red Spider, Purple Mite and Scarlet Mite. While most of the formulations are found effective, a choice amongst them is beset with difficulties, as, besides acaricidal efficiency, several other factors have to be taken into account. The question is being critically gone into.

Yellow Mite (*Hemitarsonemus latus*, Banks) had not been reported on tea untill 1955 when the first record was made of its occurrence on tea on an estate in the Nilgiris. Since then it was found on a few other estates in the same district, but not in other districts. During the year under report, this mite was noted on one or two estates in Central Travancore and it is not improbable that its distribu-

tion is much wider than is at present realised. The peculiar growth of shoots and the stunting effect characteristic of the mite's attack were severe on individual bushes, but spraying with wettable sulphur resulted in complete control.

Shot hole Borer : This pest has continued to be of some concern in Central Travancore. The results of field trial undertaken last year with systemic insecticides and fungicides were inconclusive. Further trials are contemplated for the coming year.

ACKNOWLEDGEMENTS

The Scientific Department has received during the year a considerable measure of assistance from the planting industry and other organisations connected with planting. To them and to the Agents and Managers of estates who have helped us in the conduct of field experiments, my grateful thanks are due. I am also grateful to the members of Tea Product Sub-Committee for their help and guidance and to the UPASI secretariat for their ready cooperation and assistance throughout the year.

In conclusion, I wish to express my colleagues' and my gratitude to the Managers of estates visited during the year for the hospitality extended to us.

S. ANANDA RAU
Chief Scientific Officer

Months		Rainfall in MM.	No. of days with rain	Air		Soil*		Humidity		Vapour Pressure		Cloud	
				Average noon maximum	Average over- night minimum	8.30 A.M.	3.00 P.M.	8.30 A.M.	3.00 P.M.	8.30 A.M.	3.00 P.M.	8.30 A.M.	3.00 P.M.
				°C	°C	°C	°C						
April	1960	125.5	13	28.6	18.3	26.4	28.6	95.0	72.6	23.7	24.9	—	—
May	„	237.2	18	26.3	18.7	26.0	27.8	92.9	84.5	23.1	25.0	2.0	2.2
June	„	183.4	20	23.8	18.4	24.8	26.0	91.4	87.8	21.9	23.2	3.4	3.8
July	„	519.9	26	23.1	17.8	22.5	25.5	98.3	92.2	22.1	23.9	6.2	6.0
August	„	210.3	26	23.3	17.4	24.2	25.5	94.4	87.8	21.6	22.8	3.4	4.1
September	„	144.3	26	23.6	17.6	24.6	25.6	95.7	89.9	21.8	23.4	3.8	3.4
October	„	107.7	13	25.9	16.8	24.1	25.9	87.1	70.7	20.1	21.2	0.7	1.0
November	„	156.2	17	23.6	18.1	23.3	24.1	90.4	77.8	19.6	20.2	1.4	1.3
December	„	5.8	1	25.3	15.0	21.5	23.3	85.0	56.0	17.6	16.9	—	—
January	1961	—	—	25.4	15.6	21.5	23.6	91.2	53.2	18.1	16.4	—	—
February	„	13.2	2	18.1	15.8	23.3	25.8	90.5	51.1	19.2	17.9	—	—
March	„	17.8	1	30.3	17.4	26.0	28.9	86.7	45.7	21.4	18.5	—	—
Total		1721.3	163	* at 1 foot depth									

REPORT OF THE SOIL CHEMIST

(1960—1961)

Advisory :

The work of the chemistry section followed exactly the same pattern of the previous years, i.e., routine analysis of soils, fertilisers, fertiliser mixtures, insecticides, fungicides, etc. As usual, co-operation was given to the Plant Pathologist in trials conducted against blister blight. The number and nature of analyses carried out during the year are given below :

Soil samples	397
Manures and Manure mixtures	56
Fungicides and Insecticides	15
Rubber leaves	40
Compost	1
Made tea	7
Lime	1
Total number of estimations	1176

Several general enquiries on tea cultivation received attention during the year.

Soils :

Examination of soils from prospective nursery sites was the main feature of soil analysis work.

A large number of soils was received along with weed specimens for testing the reaction of the soil and for examination of roots of weeds for eelworm infestation. This is indeed commendable as the necessity for such an examination before starting a nursery seems to have been generally realised. In one or two instances, failure to have the weeds examined beforehand resulted in tea seedlings being attacked heavily by eelworm. It is claimed that Nemagon could be used in the nursery after the seedlings are found attacked, but the rate at which this fumigant should be used without being phytotoxic to the seedlings has yet to be worked out. If eelworm infestation is found present before starting the nursery and if an alternate source of soil is difficult to locate, then the only other alternative is to have recourse to either fumigation or heat sterilisation. It was only in a few instances that soils sent for pH test were found to be under acid for tea.

Several soil samples were received from poor areas of tea accompanied by requests to find whether the analysis of the soil would reveal the cause of poor growth. Routine analysis of soils for major plant foods like nitrogen, phosphoric acid and potash is not in any way useful to find the cause of poor growth. As has

been stressed in earlier reports there are very many factors involved in the growth of a plant of which soil is one. Unless details of other factors like rainfall distribution, prevalence of pests and diseases, aspect of the fields in question, shade position, nature of subsoil, are known it is difficult to pinpoint the cause of poor growth. Moreover, we have not been able to fix a limit for deficiency of the different plant foods in the soil below which the plants will begin to suffer in growth. Much analytical work of soils from all tea growing areas is necessary for a proper approach to this problem. All samples received from estates were tested for reaction and organic matter only and, except in rare cases, organic matter content was good and reaction suitable.

The question of application of lime to soils of very high acidity was raised during the year in the course of advisory work. While tea is intolerant of very low acidity, it may be said to be tolerant of high acidity. The extent of change of pH value of a soil from lime application depends on the texture of the soil, its organic matter content and the initial pH value. The rate of application in the field is generally two to three times the calculated figure from laboratory estimation. For example, for a soil from the Nilgiris area with an organic matter content (% Carbon $\times 1.72$) of 5.1% and an initial pH value of 4.55, about 6 tons of lime would be required under field conditions to raise the pH value to near about 5.5. Application of such a large quantity is not only prohibitive in cost, but generally unnecessary. The Department recommends once in three years lime application at the rate of 10-15 cwts. per acre which will tend to prevent the further lowering of already low pH values, as a result of the continuous application of large quantities of physiologically acid manures like ammonium sulphate.

Manures and Manure Mixtures :

Majority of the samples received for check up conformed to the guaranteed figures. In a few instances the laboratory figures failed to conform to the guarantee given by the suppliers. The necessity for proper sampling of the fertiliser mixtures has been stressed more than once.

Fungicides and Insecticides :

The suspension figures of the wettable copper fungicide samples examined were satisfactory. At the request of a plant protection firm, samples of tea from bushes sprayed with insecticides were prepared by small scale manufacture in the laboratory for taint tests. The analysis of rubber leaf samples for surface copper was also undertaken for the same firm.

Publication :

Two articles, one entitled "Is application of a phosphatic fertiliser necessary for tea?" and the other on "What one should look for in selecting soils for a tea nursery?" were contributed to the *Planters' Chronicle* for inclusion in the series 'Notes on Current Problems'.

Research :

Blister Blight Trials: Co-operated with the Plant Pathologist in the trials with several fungicide formulations for the control of blister blight, details of which appear in the Appendix.

Field Experiments: The recording of yields from the eight plots of the 27-plot experiment on the Station was discontinued as it was not considered worth while to continue the same.

A new trial was started on a neighbouring estate to test the comparative efficiency of different sources of nitrogen. This trial consists of the following treatments:— (1) Ammonium sulphate, (2) Ammonium sulphate nitrate, (3) Calcium ammonium nitrate, (4) Chilean nitrate and (5) Urea, as sources of nitrogen. It was intended to include ammonium chloride also, but as supplies were not available in time, the routine estate mixture was substituted as the sixth treatment. Phosphoric acid and potash were supplied as mineral phosphate and muriate of potash respectively. The quantities of N, P_2O_5 and K_2O applied were adjusted to conform to the estate practice. In the first five treatments, they were given in two equal doses and in the sixth treatment the estate practice was followed, i.e. $\frac{2}{3}$ post-monsoon and $\frac{1}{3}$ pre monsoon. The first application of the fertilisers was made in the second week of October 1960 after recording of preliminary yields for 13 rounds. The yield figures are given below :

Preliminary yield in kg./hectare (9-7-1960 to 13-10-1960)

1. Ammonium sulphate	...	661.2
2. Ammonium sulphate nitrate	...	679.9
3. Calcium ammonium nitrate	...	632.0
4. Chilean nitrate	...	639.1
5. Urea	...	662.8
6. Estate mixture	...	668.3

The differences are not significant, indicating uniformity of yields in all the plots prior to application of fertilisers.

Yield in kg./hectare (14-10-1960 to 31-3-1961)

1. Ammonium sulphate	...	807.9
2. Ammonium sulphate nitrate	...	890.1
3. Calcium ammonium nitrate	...	816.5
4. Chilean nitrate	...	815.5
5. Urea	...	793.8
6. Estate mixture	...	829.6

The differences between the treatments are not significant.

In order to assess the effect of long term use of the different types of nitrogenous fertilisers on the fertility of the soil, especially the reaction, soil samples have been collected from all the plots for pH determination and chemical analysis.

General :

The undersigned was on sick leave for two months during the year.

ACKNOWLEDGEMENTS

Thanks are due to the Superintendent, Mayfield Estate for affording necessary facilities for starting the manurial trial referred to above and to Messrs. Rallis (India) Ltd , for free supply of fertilisers for the trial.

V. JAYARAMAN,
Soil Chemist

REPORT OF THE BOTANIST

(1960—1961)

1. Advisory :

Technical enquiries dealt with by the Botanist related to such subjects as pruning of tea, selection and vegetative propagation of tea, tea seed gardens, moss and lichen removal, green manure crops and shade trees, weed control and identification of plant specimens.

I was deputed to serve on a special committee set up by the Coffee Board to advise on a die-back of arabica coffee, which was causing some concern to coffee estates in Mysore and Coorg.

2. General :

In the absence of Mr. V. Jayaraman, Officer-in-Charge, on leave for two months (15th July to 15th September), I looked after the routine work of the Experiment Station.

During the year many persons visited the Experiment Station and I had an opportunity of meeting them and discussing with them several aspects of tea culture and matters pertaining to plantation crops in general.

3. Visits :

A few visits were made to tea estates in and around Devarshola in connection with vegetative propagation of tea and weed control in tea fields.

During September / October 1960, I visited 38 coffee estates in Mysore and Coorg along with the other members of the committee set up by the Coffee Board for an assessment of the die-back of arabica coffee. This tour involved a travel by road of over 1500 miles within a short period of a fortnight, and it also gave me an opportunity to meet many planters and discuss several aspects of coffee culture and also gain a firsthand knowledge of the diverse conditions under which coffee is grown in Southern India. A joint report containing our impressions on the problem of die-back and suggestions for future investigation was submitted to the Chairman of the Coffee Board. A visit was also made to the laboratory and the field stations of the Citrus Research Scheme in October 1960.

In November 1960, I attended the Seventeenth Annual Conference of the Scientific Department of the Indian Tea Association held at Tocklai Experimental Station, Cinnamara, Assam on the 15th, 16th and 17th of the month. On the first day of the Conference, three papers on 'Long term agronomic research' were presented by the staff of the Tocklai Experimental Station. Three papers on machinery and manufacture were read on the second day. The third day was devoted to problems of engineering development and manufacture, and demonstration of

experimental machinery was arranged in the Pilot Factory at Tocklai. The delegates to this Conference were taken round the laboratories at Tocklai and the Borbhetta Experimental Garden where they were introduced to the botanical and agronomical research carried out by Dr. W. Wight, Dr. D. N. Barua, Mr. S. K. Dutta and their associates. I availed myself of this opportunity to visit two tea gardens in the vicinity of Jorehaut to gain some knowledge of the conditions under which tea is grown in Assam. This visit to Assam was, indeed, very rewarding in that I could meet fellow scientists at Tocklai and visiting scientific workers and discuss several problems of mutual interest to us.

4. Publications :

The following papers were communicated to the press during the year.

- i. "A new species of *Cylindrocladium* parasitic on tea roots" (jointly with Dr. C. S. Venkata Ram) - accepted for publication in *Current Science*.
- ii. "Source of propagation material and its influence on rooting of tea cuttings" - accepted for publication in the *Journal of the Indian Botanical Society*.
- iii. "Is any tea clone really resistant to blister blight?" (jointly with Dr. C. S. Venkata Ram) - *Planters' Chronicle*, 55 (1960) : 446.
- iv. "Dalapon - a promising grasskiller" - *Planters' Chronicle*, 56 (1961) : 60.
- v. "Are hormones useful in rooting of tea cuttings?" - *Planters' Chronicle*, 56 (1961) : 77.
- vi. Review of the book "Bananas" by N. W. Simmonds, *The Hindu*, July 12, 1960.

The following papers are given in the appendix to this report :

- vii. "Rooting of tea cuttings as influenced by treatment with indolebutyric acid".
- viii. "Effect of some treatments on the growth of tea seedlings".
- ix. "Rooting of tea cuttings as affected by some chemical treatments".
- x. "Striking of tea cuttings as influenced by the rooting medium".
- xi. "Sensitivity of tea seedlings to some triazine weedkillers".
- xii. "Reduced light intensity and growth of young clonal tea plants".
- xiii. "Effect of aluminium sulphate and some sequestrene compounds on the growth of young tea plants".
- xiv. "Bud-break in pruned tea bushes as affected by treatment of the frame".

5. Research :

TEA (*Camellia sinensis*)

A. 'Banjhi' formation in mature tea bushes :

Selected mother bushes were being harvested at periodic intervals for a study of their yielding potentiality and this opportunity was availed of for recording the flushing behaviour of the bushes. At each pluck, the number of 'flush' (2 leaves and a bud) shoots and 'banjhi' shoots were counted and thus the percentage of 'banjhiness' of the harvest was ascertained. The results obtained with six mother bushes are given in the following table :

Date of harvest	Percentage 'banjhi' shoots in bush					
	B-4	B-80	B-81	B-82	B-83	B-84
16-2-1960	34.2	38.0	33.3	40.0	32.3	28.7
25-2-1960	29.6	26.0	28.0	31.4	30.2	32.8
4-3-1960	36.0	31.5	29.6	31.0	27.4	27.6
14-3-1960	38.0	34.3	30.0	28.5	25.6	34.3
22-3-1960	38.6	35.0	32.0	30.8	27.0	37.6
31-3-1960	36.0	31.5	30.6	27.5	23.5	40.2
8-4-1960	32.3	30.0	27.7	26.7	26.3	20.0
18-4-1960	30.4	23.2	26.0	20.4	21.3	18.0
27-4-1960	28.0	19.0	21.2	20.3	21.2	19.3
5-5-1960	17.0	14.4	18.0	15.2	18.7	15.4
13-5-1960	19.0	14.0	16.0	17.9	14.6	12.6
20-5-1960	21.4	19.7	23.5	21.0	16.5	18.0
27-5-1960	48.0	40.0	38.0	34.2	40.3	38.0
3-6-1960	63.4	42.3	45.6	44.5	49.4	45.6
10-6-1960	71.8	51.0	52.0	56.7	54.2	51.8
17-6-1960	70.0	58.2	52.0	56.0	54.2	48.6
24-6-1960	70.0	62.0	49.0	52.0	61.0	44.7
1-7-1960	61.5	56.0	52.0	48.0	58.6	48.0
8-7-1960	57.3	50.6	52.6	46.0	47.5	44.2
15-7-1960	50.2	50.0	51.8	47.0	45.3	46.4

In general, it would be seen that the percentage of 'banjhi' shoots is small in February and it is followed by an increase in March. There is again a marked decrease in late April and May. The banjhihness increases again in June, followed by a slight decrease in July. The data for the period earlier than February were not available, but it would appear that rise in temperature in February might have induced growth and this resulted in decreased banjhi shoots. It is a recognised phenomenon that in February and early March, inspite of the driest period of the year, many evergreen trees put forth fresh foliage, and the tea bush is no exception to this. The shoot growth following the rains in March and April also showed a low 'banjhi' percentage and this was the period when a general 'rush' of crop was noticed. Increase in 'banjhi' shoots could be noticed during the period immediately following the 'rush' crop (figures for late May and June), and this was what was expected. The rains had set in and the weather conditions were practically uniform during June and July, and the increased 'banjhi' could not be attributed to any environmental conditions. It is logical to assume that it could be due to imbalance in the nutritional physiology of the bush.

Examination of these results would show that banjhi formation is not only a seasonal factor, but is also likely to be influenced by the inherent (genetic) characteristic of the bush. The data available at present, however, are inadequate to say whether 'banjhihness' is governed by the genetic make-up of the bush, and it would be interesting to examine further the flushing behaviour of these clones.

B. Bud-break in pruned tea bushes :

A small critical experiment with six treatments carried out during the pruning season showed that caustic soda wash (2% solution) and lime wash (10% suspension) were superior to the other treatments in aiding bud-break. This experiment also revealed that the centre of the bush is more productive than the periphery. Details of this experiment are given in an article in the appendix to this report.

C. Vegetative Propagation :

(i) *Selection*: Of the several bushes marked out and studied at the Tea Experiment Station, Devarshola, five appeared to be promising. Their yields were 3 to 5 times the field yield during the period of observation. Two of these bushes were also capable of producing teas better than the average.

(ii) *Growth substances*: Several trials were made and a brief account of two of them are given in the appendix (see articles: (1) "Rooting of tea cuttings as influenced by treatment with indolebutyric acid", and (2) "Rooting of tea cuttings as affected by some chemical treatments").

In one of the trials commenced in April 1960, treating the cuttings of clone 'DRB' with indolebutyric acid (IBA), naphthalene acetic acid (NAA) and combination of IBA and NAA, nicking the bark at the basal end and then treating with these growth substances, all resulted in a better root system than in the untreated control. At the end of 26 weeks the results were as follows :—

<i>Treatment</i>	<i>Dry weight of roots per cutting (mg.)</i>
1. Control (untreated)	224
2. IBA (5,000 p.p.m , quick dip)	395
3. IBA (10,000 " ")	388
4. NAA (5,000 " ")	238
5. NAA (10,000 " ")	250
6. IBA+NAA (2,500+2,500 ")	420
7. IBA+NAA (5,000+5,000 ")	450
8. Nicked Control	310
9. Nicked+IBA (5,000 p.p.m.)	430
10. Nicked+IBA (10,000 p.p.m.)	460
11. Nicked+IBA+NAA (10,000 p p.m.)	441

It is also evident from these results that combination of IBA and NAA exerts a synergistic effect on rooting of tea cuttings.

In another trial started in May 1960, treating the cuttings with IBA, spraying the mother leaf with urea (1%) solution and sucrose (2%) solution, and combination of growth substance treatment with nutrient sprays resulted in quicker rooting. The results were as follows :—

<i>Treatment</i>	<i>% rooting after 11 weeks.</i>
1. Control	52.5
2. IBA (5,000 p.p.m., quick-dip)	80.0
3. Urea spray (1% solution)	72.5
4. IBA+Urea spray	85.0
5. IBA+Sucrose spray	80.0
6. IBA+Urea+Sucrose spray	87.5

These experiments are being continued and a few new trials have been planned. The results of all these trials will be reported later.

'Phyomone', a proprietary product of Messrs. Plant Protection Ltd., England, which is used for prevention of fruit drop in orchards, was tested for rooting purposes. Cuttings were sprayed with different dilutions of this hormone and the preliminary indications are that it might prove useful.

'Seradix' and Planofix', two proprietary products of Messrs. May & Baker, Ltd., have been received for trial and an experiment with these and other products has been planned for next year.

(iii) *Micro-nutrients and rooting of cuttings*: Application of salts of manganese, zinc, iron and boron to the rooting medium and spraying the mother leaves with dilute solutions of these salts did not in any way influence the rooting of cuttings of clones 'BBRB', 'DRB' and 'B-34'.

(iv) *Rooting medium*: Last year's findings that a sandy loam is preferable to clay loams as rooting medium and that a low pH value (or higher acidity) is more conducive to rooting than high pH values were confirmed. The article "Striking of tea cuttings as influenced by the rooting medium" (see Appendix) summarises the present position. At this stage, it must be added that we do not have precise information as to how a low pH value influences the rooting of cuttings—whether it is a direct effect of the acidity of the medium or the effect of other changes (nutritional or air/moisture ratio) brought about by the acidification of the rooting medium.

(v) *Juvenility and its influence on rooting of tea cuttings*: The rooting capacity of cuttings taken from (a) 30-year old bearing bush, (b) juvenile material from the pruned mother bush and (c) green-wood portion of 2-year old clonal plants were studied in three clones 'B-34', 'DRB' and 'BBRB', and it was observed that juvenility of the propagation material has a definite influence on rooting of cuttings. Cuttings taken from rested shoots on bearing bushes rooted poorly and slowly. Those from young plants rooted quickly and those from the newly developing shoots on pruned bushes also rooted equally well, though not so quickly as those from young plants. It would appear that in the tea bush, the juvenile characteristic could be restored by a suitable pruning technique and our results lend support to the customary practice of pruning the selected parent bush and taking cuttings from the green-wood portion of young shoots developing on the pruned frame of mature bushes. A detailed paper has been submitted for publication in the Journal of the Indian Botanical Society.

(vi) *Excess callus formation in cuttings:* Our observations indicate that in tea cuttings, excessive development of callus tissue at the basal end of the cutting, in general, may be brought about by one or the other of the following factors:

- (a) genetic or inherent – cuttings from some bushes develop a large callus tissue and throw out no roots, others put out roots early without any visible evidence of callus formation, while still others produce both.
- (b) effect of rooting medium – pure sand, equal parts of sand and moss and a very high percentage of sand in the soil encourage the formation of excessive callus growth at the expense of rooting. It is also our experience that a high pH value of the rooting medium is conducive to abnormal growth of callus tissue.
- (c) air-moisture relationship of the rooting medium – both high and low air-moisture ratio of the medium are favourable for the excessive development of the callus tissue at the cut-end buried in the medium. Too much moisture (water-logging) is, in general, responsible for 'clubbing' and inhibition of root formation.
- (d) injudicious use of chemical soil sterilants – in one of our experiments, we noticed that application of BHC (5% dust) to the medium inhibits root growth and the root initials produced get 'clubbed' and a thick callus and abnormal growth of roots are noticed at the basal end of the cutting.

(vii) *Development of flowers in cuttings:* Development of flowers in tea cuttings in the callusing or rooting beds is not a common feature. However, flowering can take place due to certain physiological conditions referred to below.

If the cuttings are taken from mature bushes in plucking, flower initials may have set in already and in such cases, the bud in the axils of the mother leaf develops into the reproductive phase. Such a feature is more common in China and Hybrid jats than in the broad-leaved Assam jats, as the former jats have a tendency to produce flowers early. For this reason and for others as well, it is not desirable to take cuttings from bushes under plucking.

Flowering can take place also under certain conditions in cuttings taken from fresh growth developing on pruned bushes. We have observed such a feature in cuttings which are allowed to grow in callusing beds even after the initiation of roots and we have reasons to attribute this to nutrient imbalance. In a trial carried out, spraying the rooted cuttings with 0.5% crystalline urea solution prevented the

development of flowers. Removal of the flower buds, as they are noticed, helps the development of the vegetative phase of the axillary shoot, and judicious application of nutrients has a decided added advantage, especially after the cuttings have formed roots.

(viii) *Rooting as affected by starch reserves:* It is well known that carbohydrate reserves are helpful in callus and root formation in plant cuttings in general. Tea is no exception. Micro-tests for starch in the stem portion of the cuttings indicated that some of the clones, which readily rooted, had a higher starch content than those which were shy-rooters. In one clone, however, the relationship between starch content and rooting was not very evident. These are only preliminary observations, but they indicate at least one possible reason for rooting differences in clones. This subject should be followed up with uniform material derived from as many clones as possible and it would also be desirable to estimate the starch content quantitatively. In this connection, it may also be added that treating the cuttings with sucrose showed a beneficial effect, and this has been commented on elsewhere in this report.

(ix) *Polythene covers:* It has been mentioned in earlier reports that polythene film is useful in the vegetative propagation nursery. Our further experiments have proved in ample measure the usefulness of this versatile material. The main benefit derived from the use of this material is the maintenance of high humidity over the cuttings, which is an essential factor in successful rooting of tea cuttings. The cutting is not well adapted for the absorption of water and the mother leaf is a source of continuous loss of moisture through transpiration. This loss could be minimised by heavy shading, but it must be remembered that such heavy shading, would adversely affect the food producing power of the mother leaf. Root development in the cutting depends on the production of callus and then the differentiation of root initials and these can take place only with the help of food reserves available in the cutting and with adequate amounts of moisture. This would clearly illustrate the necessity for sufficient light energy for the mother leaf to manufacture food and for the maintenance of high humidity and conservation of moisture in the rooting medium. With the use of polythene, we find that a greater intensity of light than in a normal propagation nursery, could be allowed and that this helps in early callusing and rooting.

D: Effect of some treatments on germination and growth of tea seedlings:

Some soil insecticides are used now and then in tea nurseries to prevent ant and other insect damage, but it is not clearly understood whether such treatments have any effect on the early growth of seedlings. A few preliminary trials were

undertaken with BHC, Aldrex and Dioldrex and the results are presented in a short paper included in the appendix (see article entitled "Effect of some treatments on the growth of tea seedlings").

It is known that Agrocide 50 (50% BHC) has an adverse effect on tea seedlings and it now appears that injudicious soil application of even a 5% BHC dust could cause considerable damage to tea seedlings. Aldrex and Dioldrex did not affect the growth of the seedlings.

E. Reduced light intensity and growth of young tea plants :

The effect of reduced light intensity on the growth of young clonal tea plants was studied. For want of facilities, only the effect of two light intensities were investigated, viz. 100% light (full exposure) and 58% of the light intensity in the open (this was adjusted by means of woven coir-matting). The plants were carefully removed from the pots in which they were grown and examined for shoot growth, leaf area and root growth, four months after the commencement of the experiment. These observations, detailed in a paper entitled "Reduced light intensity and growth of young tea clonal plants" and appearing in the appendix to this report, showed that young plants benefited by shading. The chlorophyll content of the leaves of the shaded plants was higher than that of the leaves of the plants kept in the open.

Soil temperature and relative humidity records also showed that the soil temperature was lower and the relative humidity higher in the shaded than in the unshaded area.

The soil temperatures at a depth of 75 mm. were as follows in January 1961 :

	<i>Soil temperature in °C at</i>		
	<i>9 a. m.</i>	<i>12 noon</i>	<i>3 p. m.</i>
Unshaded	17.4	22.7	23.1
Shaded	15.9	18.9	19.4

The relative humidity in a shaded and unshaded tea field was as follows in January 1961 :

	<i>Relative humidity (%) at</i>		
	<i>9 a. m.</i>	<i>12 noon</i>	<i>3 p. m.</i>
Unshaded	58	44	39
Shaded	78	63	62

F. Effect of aluminium sulphate and some sequestrane metal chelates on the growth of young tea plants :

A pilot trial was undertaken to determine whether application of aluminium sulphate and some metal chelates to the soil has any effect on the growth of rooted clonal tea plants. At the rate at which the metal chelates were tried (2 g. per 1000 g. of air-dry soil), calcium had an adverse effect on the growth of both roots and shoots, and copper and zinc had no effect. Aluminium sulphate assisted in better rooting of the plants. The details of this experiment are given in a short paper given in the appendix to this report.

G. Root system of young tea plants as affected by soil cover :

A preliminary pot trial was started with clonal tea plants to see whether clean cultivation of the soil surface, grass growth and use of an inert mulch over the soil surface have any effect on the kind of root system formed. The experiment has not progressed far and it is premature to comment on this trial.

H. Weedkiller experiments :

(i) *Sensitivity of tea seedlings to some triazine compounds :* A pot trial employing uniform sized tea seedlings (Manipuri jat) showed that Simazine and Atrazine could be safely used upto a concentration of 4 p.p.m. of the active ingredient in the soil. At higher concentrations, phytotoxic symptoms developed on the seedlings within a month of treatment. The results of this trial are detailed in a paper entitled "Sensitivity of tea seedlings to some triazine weedkillers" (see Appendix).

(ii) *'Tafapon' formulations :* Two sets of formulations of 'Tafapon', which is based on 2:2, dichloropropionic acid, were tested against some grasses both in the laboratory and in the field. Some of these formulations compared very favourably with Dowpon, which is a proprietary product of Messrs. Dow Chemical Co. of the U. S. A.

In the laboratory trials, it was observed that the kill of the grasses was not 100 per cent. unless all the leaf blades received at least some amount of the weedkiller. Similarly, sudden killing of the leaf tissue with a high concentration of the weedkiller prevented systemic translocation of the chemical into the plant and the untreated parts of the plant were not therefore killed. Essentially similar results were obtained with Dowpon.

(iii) *'Reglone' :* A new weedkiller, 'Reglone' - 40% solution of diquat (1:1, ethylene -2:2'- dipyridylum dibromide) received from Messrs. Plant Protection Limited, England, was tried against certain dicot and annual monocot weeds. It was very effective in killing all these weeds even at a high dilution of 1 in 500. Even at 1 in 1000, most of the annual dicot weeds were readily killed with one application.

Tea plants are susceptible to this weedkiller and, therefore, it cannot be used in tea fields. In mature plants sprayed with 'Reglone', all the leaves shed within a week and tender branches were killed; the entire bush, however, was not damaged. Careful application of 'Reglone' to weeds on the soil surface did not affect the tea plants, but such application in the field by estate labour is not practicable.

(iv) *Grass weed control in tea fields*: Two experiments were started during the year, one at the Tea Experiment Station, Devvarshola, and the other on Davera-shola Estate. It is too early to comment on these experiments but for the sake of recording results, they are presented here.

Trial at the Tea Experiment Station :

Twenty-five 50-bush plots were marked out in a first year tea field and the experiment comprised the following treatments :

- (a) Control - Untreated.
- (b) Hand-weeded to remove all grasses once at the start of the experiment.
- (c) & (d) Tafapon application - 5.35 kg./ha. in 561 l. of water two and three applications.
- (e) Tafapon - 5.35 kg. in the first application, 3.36 kg. and 2.24 kg. at the second and third applications.

Preliminary yields were recorded from the experimental plots for 23 rounds of plucking (20th June to 23rd November 1960) and they are presented below :

<i>Plots marked for treatments</i>	<i>Green leaf in kg. from 250 bushes (5 plots) for 23 plucking rounds.</i>
(a)	171.8
(b)	175.5
(c)	185.0
(d)	160.9
(e)	187.3

The differences were not statistically significant and, therefore, the five blocks and the experimental plots were considered to be of uniform yielding capacity.

The first application of the weedkiller, at 5.35 kg./ha in 561 l. of water, was made on the 26th October 1960 to all plots receiving weedkiller applications. Five plots were weeded, digging out all grasses without injuring the tea roots as far as possible and these plots did not receive any weedkiller application. Five other plots were left untreated as controls. The second application of the weedkiller will be made in April or May as soon as some rain is received. The yields from the experimental plots up to end of March 1960 are given below :

<i>Treatments</i>	<i>Green leaf in kg. from 250 bushes (5 plots) for 12 plucking rounds (up to 15-3-1961).</i>
1. Untreated	65.0
2. Hand-weeded	62.7
3. Tafapon	64.1
4. Tafapon	62.3
5. Tafapon	66.4
} 1st application at 5.35 kg./ha. given	

The differences are not significant. The effect of hand-weeding or one application of the weedkiller has not been felt so far, and it is too early to draw any conclusion as the experiment has run only for a short while.

Heavy rain followed the application of the weedkiller and there was some leaching of the weedkiller into the soil. Although growth of grass was checked and the tea bushes did not exhibit any phytotoxic symptoms, the 'dadap' trees in the experimental plots were adversely affected. Shedding of foliage was first noticed in January 1961, nearly two months after the weedkiller application and gradually the trees shed almost all their leaves. The trees, however, were not killed and refoliation was noticed in some of them early in March 1961.

Trial on Daverashola Estate :

This trial was planned to find out whether reduced application of Dowpon would be effective in controlling grass weeds. A uniform area was chosen in a pruned field and twelve plots, each of 200 bushes, were marked out in September 1960 when the pruned bushes had put forth foliage. The experiment comprised the following treatments :

- (1) Untreated control
- (2) Dowpon : 2 applications at 5.35 kg./ha. in 673 l. of water.
- (3) Dowpon : 3 applications, 5.35, 3.36 and 2.24 kg./ha.

The experimental plots were plucked according to estate practice from the 12th September to the 19th December 1960 (14 rounds) and this constituted the preliminary yields, which are given below :

<i>Plots marked for treatments</i>	<i>Green leaf in kg. from 800 bushes (4 plots) for 14 plucking rounds.</i>
(1)	564.1
(2)	559.5
(3)	561.4

As the differences were not significant, the plots were taken to be of uniform productive capacity and the first weedkiller application was made on the 23rd December 1960. Until the end of the official year, 8 harvests were made from the experimental plots and the yield figures are as follows :

<i>Treatment</i>	<i>Green leaf in kg. for 800 bushes (4 plots) for 8 plucking rounds (up to 20-3-1961).</i>
Control	308.6
Dowpon } 1st application	349.5
Dowpon } at 5.35 kg./ha.	340.5

In this case, the treated plots have yielded more than the untreated controls. It is difficult to say whether this increase is due to the check of weeds in the treated plots during the dry months and it remains to be seen whether the difference will be maintained.

Young dadap and grevillea trees in this experimental area were not damaged as there was no rain immediately following the weedkiller application.

The second application of the weedkiller is to be made in April or May depending on the weather conditions.

MISCELLANEOUS

6. Coffee :

During the visits to several coffee estates with a view to investigate the possible causes for the die-back of arabica coffee reported from Mysore and Coorg, I had an opportunity to come across a remarkable instance of zinc deficiency symptom and it was heartening to learn that this disorder could be cured by appropriate sprays with solutions of zinc salts. Thrips and jassids, mainly the former, were seen commonly associated with malformed shoots in more than one estate and it appeared as though infestation by these insects might have a special bearing on

this abnormal growth of coffee shoots, and I am of the considered opinion that it would be useful to investigate measures to control them and also to find out whether the indiscriminate removal of shade could have influenced the multiplication of these pests, which have been considered hitherto to be only of minor importance.

7. Citrus :

A few mandarin orange trees at the Experiment Station showed yellowing of the foliage and die-back of branches. In one case, thickening of the veins of the leaf blade, particularly noticeable on the upper surface and splitting of such veins were observed. This latter symptom is reported in literature to be typical of both boron deficiency and tristeza virus. Spraying the affected shoots thrice with 0.5% borax solution did not have any effect and the symptoms developed on previously healthy leaves on the treated shoots and it would appear that it is not due to boron deficiency. Similar symptoms were observed on several plants in the Nilgiri-Wynaad, Mysore and Coorg. The fact that tristeza virus and its insect vector have been reported from this country in recent years has to be taken into serious consideration and every effort should be made to eliminate the possibility of this dreaded virus being the cause of the decline of mandarin oranges in South India. If, indeed, it is proved that the devastation of citrus groves in the country is due to this virus, we should soon learn to rehabilitate the orchards by appropriate methods.

8. Herbarium :

Specimens of *Camellia kissi* Wallich, *C. caudata* Wallich and *C. irrawadiensis* P. K. Barua were collected from Tocklai Experimental Station, Assam, and Dr. Wight was kind enough to lend me a few herbarium sheets. Sheets of over 150 plant species collected from Mudumalai and Naduvattam were prepared. An attempt was made to collect as many weed species as possible. As these herbarium material and seed specimens are useful in the identification of plants received from estates from time to time, it is proposed to augment the present collection and maintain a herbarium at the Experiment Station.

ACKNOWLEDGEMENTS

I am grateful to Dr. N. G. Chokkanna and his colleagues at the Coffee Research Station, Balehonnur, Mysore State, Mr. H. Ferguson and his team of workers at Tocklai Experimental Station, Cinnamara, Assam and Dr. K.M. Aiyappa and his associates at the Citrus Research Station, Gonicoppal, Coorg for the courtesies extended to me during my visit to these institutions. I am also thankful to the Managers of estates visited for their hospitality and assistance in carrying out my investigations. Several firms have generously supplied materials for work and I wish to record their help with gratitude. Assistance derived from Dr. K. Subrahmanyam and his assistants in the Botanical Survey of India is greatly appreciated and gratefully acknowledged.

K. S. VENKATARAMANI,
Botanist.

REPORT OF THE PLANT PATHOLOGIST

(1960—1961)

General :

Eighty-five specimens of disease and pest affected plants were received for examination during the year. While this was the number of reports sent out, a considerable amount of other technical enquiries and advisory correspondence was handled relating to plant pathological work.

The American Association for the advancement of Science have honoured me by electing me a fellow of this Association.

Touring :

The following visits were made during the year :—

April	1960	— Devon and Rousdon Mullai Estates, Nilgiri-Wynaad.
June	„	— Rousdon Mullai Estate, Nilgiri-Wynaad.
July	„	— Devon Estate, Nilgiri-Wynaad.
August	„	— Daverashola Estate, Nilgiri-Wynaad.
September	„	— Korakundah Estate, Nilgiris. Rousdon Mullai Estate, Nilgiri-Wynaad.
October	„	— Chembra Estate, Malabar-Wynaad. Daverashola and Rockwood Estates, Nilgiri-Wynaad.
November	„	— Daverashola, Devon, Rockwood, Woodbriar, Sussex and Rousdon Mullai Estates, Nilgiri-Wynaad and Coonoor Tea Estates, Nilgiris.
December	„	— Mayfield and Daverashola Estates, Nilgiri-Wynaad and Kadamane Estate, Mysore.
January	1961	— Devon Estate, Nilgiri-Wynaad.
February	„	— Terrace Estate, Nilgiris.

In addition to these estate visits, I attended the Tenth Anniversary of the Fulbright Programme of the United States Educational Foundation in India, of which I was a participant in 1952-53, held in New Delhi from November 17th to 20th. I was the president of the section of Botany at these meetings and in one of the technical sessions I read a paper entitled "Plant diseases take a heavy toll in tea cultivation".

Publications :

The following technical papers were published during the year :

1. "The relationship of interval and rate of application of antibiotics, copper and organic fungicides to the infection of tea plants by *Exobasidium vexans* Massee" (jointly with V. Jayaraman). A. R. UPASI sci. Dept. Tea Sect. for 1959-60, pp. 36-48, 1960.
2. "Fungi causing stalk-rot and failure of tea cuttings in vegetative propagation nursery beds and their control". A. R. UPASI sci. Dept. Tea Sect. for 1959-60, pp. 59-62, 1960.
3. "Tea Plant and control of Root Diseases, 1. *In situ* action of soil fungicides on *Fomes noxius*, *Rosellinia arcuata* and *Ustilina zonata*". A.R. UPASI sci. Dept. Tea Sect. for 1959-60, pp. 66-77, 1960.
4. "A reassessment of the Diplodia Root Disease of tea plants." UPASI sci. Dep. Tea Sect. Bull. 19, pp. 18-28, 1960.
5. "Application of Nickel chloride to tea plants and control of blister blight (*Exobasidium vexans* Massee)". *Curr. sci.* 30: 57-58, 1961.
6. "Inducing sporulation of *Colletotrichum camelliae*" *C. P. News*, Vol. 7. part 2, 1961.

With the decision of the Scientific Department to publish short semi-technical articles in the *Planters' Chronicle* under the title series "Notes on Current Problems", a few articles were communicated for publication.

ADVISORY

Root Diseases: Reports of losses due to the 'Brown Root Disease', the 'Red Root Disease', 'Charcoal Stump Rot' and the 'Black Root Disease' were frequently received. These four major root disease problems are probably more serious in tea estates in Southern India than what is indicated by the reports received. One reason for not more instances of root diseases being brought to our notice probably lies in the fact that we are unable, at the moment, to suggest any measure for their control other than plant sanitation, viz., elimination of all infected material and isolation of the disease affected area by trenching. We are going deeply into the question of chemical control of root diseases affecting tea in bearing and it is hoped that it will be possible to publish the results of the trials now under way, in the next report.

Violet Root Rot caused by *Sphaerostilbe repens* (?) was also reported several times, but invariably from tea areas where water-logging was a problem. The "Diplodia Root Disease" was noticed on four lots of tea root specimens received during the year for examination; in all cases death of the plants in question was attributed to *Botryodiplodia theobromae*. Further pot and field experiments have confirmed the potentiality of *Botryodiplodia theobromae* as a pathogen capable of causing death in healthy tea plants and these results appear in the next few pages.

An instance of death of tea seedlings, grown from seed at stake, due to *Rhizoctonia bataticola* came to light in 1960. *Rhizoctonia bataticola* is a soil fungus which causes root-rot of several plants, but generally its activity is accentuated by certain soil conditions. In tea fields, high soil pH and high soil temperature are likely to increase damage caused by this fungus. Drenching the soil around the seedlings in the affected area with a fungicide suspension will prevent the infection from spreading and minimize losses.

Stem Diseases : 'Die-back' caused by *Leptothyrium theae* continues to be a problem in estates at high elevations. *Macrophoma* 'branch canker' has also been reported from several estates and in some of these the disease has attained proportions of an epiphytotic. Control measures against both the diseases are best undertaken when the affected field is pruned. All disease affected branches should be cleaned out and soon after sprayed with a fungicide. The pruning cuts and the branches should receive a thorough drenching with the fungicide fluid.

Bushes affected by 'shot-hole borer', *Xyleborus fornicatus*, frequently die back and the cause for this was traced to certain pathogenic fungi which had gained entry into the pest affected plant through the borer gallery. An experiment at artificial inoculation of branches of pruned tea bushes with some of these fungi indicated that a species of *Nectria* and *Rhizoctonia bataticola* could cause die back of shoots and collapse of the inoculated branches. While shot-hole borer by itself rarely kills a plant, it is the fungal organisms such as *Nectria*, *R. bataticola* and possibly others, which enter through the borer galleries that cause the death of the affected plants. In a field trial employing several insecticides and fungicides singly and in combination, it was observed that spraying with a combination of an insecticide and fungicide prior to pruning tended to decrease the incidence of die-back in branches after pruning; these results were, however, not conclusive.

Leaf Diseases : Black-rot caused by *Corticium invisum* was reported from an estate located in a high rainfall area. Pruning out all the diseased branches and spraying the plants with a fungicide gives good control of black-rot.

Sooty moulds observed on tea foliage grow only superficially on the leaves and are not parasitic on the plants. By impeding light absorption they might slightly interfere with the photosynthetic activity of the plant. Sooty moulds grow on secretions of certain insects, generally scale insects and mealy bugs, and even when insects infest shade trees their secretions falling on tea bushes below lead to the development of sooty moulds on these bushes. Spraying against the insects with fish-oil-resin soap (2 lb. in 4 gallons of water) will automatically control the sooty mould.

Several cases of damage due to 'Grey Blight' were brought to notice last year. 'Grey Blight' is usually not a disease warranting control measures. However, we have in the past received reports when the damage caused by this disease in supplies was quite serious. *Pestalotia theae*, the casual organism of this disease, is a weak parasite and it infects leaf and stem tissue in tea plants which are weakened either due to malnutrition or some other disease. For instance, we know that potash deficiency causes marginal scorching of the leaves and the scorched tissue is readily infected by 'Grey Blight'. Healed over blisters and leaves affected by sun-scorch are also foci of infection for *Pestalotia theae*, and it is believed that drought affected plants are also readily susceptible to this fungus. As a rule, the 'Grey Blight' organism does not infect healthy tea shoots. Control of 'Grey Blight' should, then, automatically follow if measures are taken against the factor responsible for pre-disposing the plant to the disease. Spraying with a fungicide will prevent infection of leaves rendered susceptible by blister blight or sun-scorch.

Survey for Mite infestation: During the out-station visits in the year a serious infestation by purple mite and red spider was observed in many of the tea estates in the Nilgiri-Wynaad and in one estate in Mysore. A noteworthy feature of these observations was the heavy mite infestation seen shortly after the heavy rains.

Diseases in the V. P. Nursery: As envisaged, root-rot problems in the V. P. Nursery are gaining in magnitude with the increase in V. P. work being undertaken in Southern India. Last year we had occasion to refer to losses in the V. P. beds caused by *Rosellinia arcuata*, *Botryodiplodia theobromae*, *Colletotrichum camelliae*, *Pestalotia theae*, *Pythium* sp., *Cylindrocladium* sp., and *Fusarium* sp. This year we have recorded two other pathogens, namely *Rhizoctonia* and *Cylindrocarpon*, causing root-rot of V. P. plants. With the exception of *Rosellinia arcuata*, *Botryodiplodia theobromae* and possibly *Rhizoctonia*, all the other named fungi are facultative parasites which cause greatest damage when conditions for the growth of the plant are unfavourable. Thus, these fungi operate and cause losses when the soil moisture is either excessive impeding respiration, or when it falls too low bringing about desiccation of the roots. It has been found that plant roots subjected to wide fluctuations in soil moisture content slough off and that certain weak pathogens in the soil grow profusely at the expense of these sloughed off roots.

Root-rot caused by soil-borne fungi could also be initiated by injudicious incorporation of groundnut cake and fresh cattle manure. Undoubtedly, losses due to these fungi in the V. P. nursery could be reduced merely by proper watering and attention to shade.

The use of polythene bags for raising nursery plants is now in vogue. We have received a couple of reports where waterlogging of the soil in such bags had resulted, leading to root-rot of seedlings. Although, *Phythium*, *Cylindrocladium* and *Fusarium* were isolated from the affected seedlings, waterlogging was the predisposing factor for the fungal attack. Great care should be taken not to overwater when polythene bags are being employed, while in basket nursery it is usually underwatering which leads to root-rot.

Leaf diseases in certain clonal selections were reported last year. In one case selections from a single clone were badly affected by *Cercospora theae* while under the same environmental conditions other clonal selections were unaffected. In another instance, marginal yellowing of leaves was noticed in cuttings propagated from a particular clone while in the same area cuttings from other clones were free from these symptoms.

Post-pruning control measures: We are recommending prophylactic spraying against *Leptothyrium* 'die-back' and *Macrophoma* 'branch canker' soon after pruning in tea fields which have had a continued history of these diseases. In some of the affected fields these diseases become so chronic that unless intensive efforts at control are made, they are likely to cause considerable damage. After removal of all the disease affected branches, and in the case of 'branch canker' pruning the diseased branch well below the discoloured part, the bushes are sprayed with either 1% Bordeaux or any proprietary copper fungicide (containing 50% copper, metallic) at a concentration of 8 oz. in 10 gallons of water. The pruning cuts and the branches should receive a thorough drenching with the fungicide fluid of which approximately 40-50 gallons may be required to cover an acre.

In estates where 'Red Rust' is prevalent, spraying with copper fungicide should be undertaken to prevent sporulation of the algal organism. This will minimize the chances of fresh infection and the measure is particularly necessary when the bushes are skiffed or pruned very light. Against 'Red Rust', two rounds of application at 10-12 day intervals are suggested, the concentration of the fungicide and rate of application being the same as that recommended against 'die-back' and 'branch canker'.

Preparation of Bordeaux Mixture: While several excellent proprietary copper fungicides are available in the market, some of the estates may prefer to use Bordeaux mixture for certain good reasons. In recent years research has shown that considerable improvement in the performance of Bordeaux, particularly relating to the sedimentation rate and the tenacity and fungitoxicity of the spray

deposits, could be achieved if the lime is added in a concentrated form or in volume equal to that of copper solution. For practical purposes the convenient procedure will be to add one component of the Bordeaux mixture in a concentrated form to the other already diluted in the spray tank. It would, then, mean that the orthodox method of adding a concentrated solution of copper sulphate to a thin suspension of lime should be reversed. Supposing 2-2-40 Bordeaux is to be prepared, the procedure will be as follows: dissolve 2 lb. of copper sulphate in 38 gallons of water, make a slurry of the 2 lb. of lime with 2 gallons of water and slowly add the slurry to the copper sulphate solution, thoroughly agitating the mixture. Either a wooden barrel or a container made of a metal which will not react with copper sulphate should be employed for preparing the mixture. It is also essential that the lime which is used be of a good quality.

Blister Blight Forecasting: A number of reports have recently appeared in Indonesia and Ceylon relating to the usefulness of predicting blister blight intensity based on sunshine records, from the pragmatic point of view of minimizing spraying rounds. In Ceylon, 20 hours of sunshine in a 5-day period or 16 hours of sunshine in a 4-day period in the latter half of a 9-10 day and 7-8 day spraying round, respectively, is taken as the critical limit, above which blister blight incidence would be small and below this limit infection high and when the limit is reached or exceeded, spraying could be postponed by 5 days, or 4 days, till the sunshine value again falls below the critical limit. In Indonesia, valuations have been given to sunshine hours, less for less than 4 hours and more for more than 4 hours. The valuations for the sunshine received over a seven day period are totalled, but the values computed for sunshine on the 4th, 5th and 6th day are doubled, and if the figure is less than 40, spraying/dusting against blister blight has to be continued (in this case, a spraying round of 4 days is suggested). If the sunshine valuation is more than 40, spraying or dusting can be suspended till the figure again reaches or exceeds 40. In all these forecasting systems based on sunshine records the theory operates on the fact that blister blight spores are highly vulnerable to sunlight and succumb to it after a particular period of exposure. Sunlight, particularly morning sunshine, also dries up the dew on the tea foliage, thereby minimizing the chances of infection by the blister blight spores.

We are not confident that any system of forecasting blister blight based on sunshine hours will be useful in Southern India. One of the chief reasons for this, is the scant sunshine and heavy mist experienced in the S.W. monsoon during the blister blight season. The number of hours of sunshine at the Experiment Station last year, mean for June, July, August and September, was respectively 3.2, 1.6, 3.0 and 2.0. These figures represent abnormally high sunshine as last year was a low rainfall year with an unusually high number of days with sunshine. Based on these figures, if we were to consider the Ceylon system of prognosticating blister blight we need have made only 11 fungicide applications compared to 16 required on 7-day rounds, a saving of 5 rounds. This works out to an average of 3 fungicide applications in a

month by the Ceylon system. But we have time and again observed that on 10-day rounds of application, irrespective of climatic conditions, satisfactory control against blister blight can be achieved if a good cuprous oxide fungicide is used. In 1960 we found that spraying at 10-day intervals gave disease control which was more economical than spraying on 7-day rounds (results of this experiment are presented in the Appendix). It would, then appear, that no profits will accrue out of a forecasting system unless it indicates on the average less than three fungicide applications per month. It does not seem likely that any of the forecasting systems based on sunshine records are likely to do that under the S. W. monsoon conditions obtaining in tea estates in Southern India. During the N. E. monsoon season the sunshine records could give an entirely erroneous picture of blister blight intensity, since experience has shown that although during October and November a fair amount of sunshine is received, the intensity of blister blight is also very severe. Curiously, when the grower is struggling to keep his spraying rounds down to 7-10 days, the sophisticated forecasting system evolved in Indonesia advocates a basic 3-4 day schedule. It may also be pertinent to mention here that large scale removal of shade has been done in tea estates in Indonesia and shade is likely to influence the sunshine recorded in different parts of the field. We are going into this subject deeply and hope to be able to put out a full report by the end of the year.

SHADE TREES

Disease in Acacia decurrens: During the middle of 1960 an estate in the Nilgiris brought to our notice an instance of large numbers of *Acacia decurrens* plants shedding their leaves and finally dying. Several hundreds of Acacias were reported as having died in the past two years. The damage to the Acacias was mild in certain fields, whereas in other areas majority of the plants were dying. Curiously, 1-2 year old plants were not affected but older Acacias seemed to be very susceptible. Lopped plants seemed to be less susceptible than unlopped ones. Where the disease was mild, the terminal leaves were most often intact whilst those at middle and lower part of the branches had shed. Small necrotic spots were visible on the slender stem affected by the disease. In areas manifesting severe disease incidence, dying Acacias were found attacked by a species of *Nectria*. Infection of *Acacia decurrens* by *Nectria pulcherrima* has been previously reported, but the present species of *Nectria* has not been yet identified. Inoculation experiments with the pathogen isolated from the diseased Acacias and identification of the fungus are under way.

Disease affecting dadaps: In October 1960 death of dadaps on a large scale was reported from an estate in Malabar-Wynaad. The first instance of the disease was observed in 1958-59, but by the end of 1959 more than 50 plants had died. Subsequently, about 300 more perished and the death of such a large number of dadaps caused alarm. The first symptom of the disease is an initial paling of the

leaves; later the leaves turn yellow and at this stage a mosaic pattern is noticed in the intercostal region (between the veins). In some affected leaves vein-clearing and vein-banding could also be observed. The disease spreads rapidly from the leaves at the inner end of the branches to those at the outer end and soon the entire branch is affected and it starts declining. The slender branches appear gnarled and the whole shoot looks abnormal. The internodes in the diseased branch are short and the leaves cluster together. Invariably, necrotic spots could be seen on the leaf petiole and on the vein. Small and large dadaps were equally susceptible to the disease and the diseased area seemed to be continuously enlarging.

While no root disease or root attack by eelworm could be noticed in the affected dadaps, certain fungal organisms, as well as a bacteria, were consistently isolated from the diseased tissue (leaf petiole and branches). A species of *Homopsis*, *Colletotrichum* and another fungus producing pycnidia were found growing from the majority of the infected bits in culture. These fungi and the bacteria were inoculated on healthy dadaps when the disease symptoms were reproduced. The inoculated branches shed all the leaves and gradually declined. However, none of the inoculated plants died even 4 months after inoculation. Young dadap seedlings inoculated with the bacteria developed a pattern of yellowing and vein clearing characteristic of the disease, but were not killed. On the other hand, healthy seedlings inoculated with the pycnidial fungus soon turned yellow and died. Further pathogenicity trials with the fungi and bacteria are under way, but from the results obtained so far it would seem that the pathogen(s) are capable of killing individual branches of dadaps which they infect and that continued infection over 2-3 years affecting all the branches might ultimately result in the death of the plant. It is likely that the disease organisms are carried to healthy plants by the knife used for shade lopping.

RESEARCH

Blister Blight Trials: Three field trials each in the S. W. monsoon and the N. E. monsoon period in 1960, six in all, were carried out for the screening of fungicides against blister blight. Five new organic formulations were tested, namely, OM-1763 (experimental fungicide), OM-1562 (cupric omadine), OM-1563 (zinc omadine), OM-1565 (ferric omadine) and Gorsatox (based on 1-chloro-2, 4 dinitro-naphthalene), together with Perenox, oil based copper, Captan, Actidione S, Kirti-copper 50-W and Kirticopper 20-W. The addition of Ortho sticker to Captan did not improve the performance of the fungicide which gave poor disease control with or without the sticker. (Details of the trials are reported in the Appendix).

A trial was laid out in a neighbouring estate to again investigate the efficiency of Perenox sprayed on extended rounds in controlling blister blight. In previous plot trials in 1958 and 1959, Perenox was found to give adequate protection even when applied at 14-day intervals. In the present trial six replicates in a treatment, each with 20 x 12 bushes, randomized, were each sprayed with Perenox on 7-, 10- and 14-day rounds. Incidence of blister blight and yield were recorded weekly and

results (details are presented in the Appendix) showed that no significant difference in yield existed between the three treatments. On most of the occasions, percentage infection was statistically the same in the three treatments.

Nickel Fungicide for Blister Blight Control: For the first time a nickel fungicide was found to give spectacular control of blister blight. Investigations carried out with nickel chloride revealed that its action against the disease organism was that of an eradicant. When two sets of randomized plots with high blister blight infection were each sprayed weekly with copper oxychloride and nickel chloride at 6 oz. in 15 gallons per acre, percentage infection in the nickel sprayed plots fell steeply three weeks after fungicide application was started, whereas in this period percentage infection remained unaltered in the copper sprayed plots. Further trials indicated that nickel at half the concentration of copper normally employed in blister blight control was more effective than copper as a fungicide. Details of this work appear in the Appendix.

Nickel residue in tea: With the findings that nickel chloride had great potentialities in blister blight control, the fungicide was tested for taint and residue in made tea. It was learnt from tasters' reports on tea manufactured from leaves sprayed with nickel chloride hexahydrate at the rate of 6 oz. in 15 gallons per acre (the highest concentration tested) that no taint is imparted by nickel chloride. Analysis for nickel in the made tea gave the following results:

Concentration of nickel chloride in water	Gallonage per acre	Nickel residue in made tea
1. 3 oz. in 15 gallons	15 gallons	9 - 10 ppm.
2. 3 oz. in 15 gallons	30 gallons	15 - 16 ppm.
3. 6 oz. in 15 gallons	15 gallons	18 - 19 ppm.
4. Unsprayed, Control		4 - 5 ppm.

All samples were manufactured one week after fungicide application and during the period between application and manufacture no rain had fallen. The figures show that nickel residue in all cases is below 20 ppm., and is unlikely to produce any toxic hazards. A number of nickel fungicides will be taken up for investigation in 1961-1962.

Summary of 1960 Blister Blight Trials: The results of the fungicide screening trials carried out in 1960 have appeared in the "Results of 1960 Fungicide-Nematocide Tests" published by the American Phytopathological Society.

Resistance to Blister Blight: When the blister blight disease spread in an epidemic form in Southern India, a single bush in one of the fields at the Experiment Station was found to be free from mature blisters and this bush continued to be free from sporulating blisters for several years. Last year, however, it developed mature blisters. Another clone planted in an estate in Nilgiri-Wynaad was immune to blister blight, but this very clone was susceptible to the disease in certain other areas in Southern India. There are probably several races of *Exobasidium vexans* present in Southern India, at least three distinct ones are known, and clonal resistance to blight, if any is observed, is likely to break down rapidly with the formation of new physiological races of the fungus, a process which is continually taking place in nature.

Eradication of Blister Blight: Success has been achieved with nickel fungicides in eradicating *Exobasidium vexans* already established within the host tissue. This marks a great step forward in blister blight control, for, it provides us with a valuable tool with which we could arrest the development of blisters even after infection has taken place, preventing liberation of spores and checking the spread of the disease. With the currently employed copper fungicides it is not possible to arrest the sporulation of blisters when once infection has taken place. Use of nickel fungicide *in lieu* of copper formulations is very likely to reduce the inoculum potential of the blister blight fungus to a considerable extent. In laboratory trials with nickel chloride hexahydrate, nickel acetate, nickel sulphate and nickel nitrate it was observed that when these fungicides were employed to give a concentration of 250 ppm. of nickel as metallic, they gave good results as eradicants in blister blight control. Nickoleum, a product of Messrs. Standard Vacuum Oil Company containing nickel acetate in a specially formulated oil, also gave good results as eradicant in blister blight control.

Diplodia Root Disease: In continuation of the investigations carried out in 1959-60, further laboratory pot trials and field experiments were laid out in 1960-61 on the pathogenicity of *Botryodiplodia theobromae* to tea plants. In the pot trial, 15" x 10" alkathene bags were filled with soil and potted with 3-4 year old tea stumps which were inoculated with *B. theobromae* as (1) root inoculum and (2) mycelial suspension of agar culture of the fungus. Three months after inoculation, the percentage survival of the plants was as follows:

Nature of inoculum	No. of stumps inoculated	Percentage survival
1. Inoculated with root-bit inoculum of the fungus	60	58
2. Inoculated with mycelial suspension of the fungus	20	45
3. Control, Uninoculated	20	80

In the field trials, the stumps (3 - 4 year old) were inoculated with root-bit inoculum (*Botryodiplodia theobromae* grown on pieces of autoclaved tea roots) and the results were as follows, 3 months after inoculation.

Experiment No.	Percentage stumps dead in the inoculated plot	Percentage stumps dead in the uninoculated plot
Experiment 1	65	10
Experiment 2	43	0
Experiment 3	66	20

These observations taken in conjunction with previous results (published in the UPASI Scientific Department, Tea Section, Bulletin No. 19, pages 18 - 28) provide conclusive proof of the pathogenicity of *Botryodiplodia theobromae* to tea plants. But the question still unanswered is how the fungus attacks tea roots when it is normally not resident in the soil. How does infection take place in the field under natural conditions?

Eradication of root disease: Unfortunately, due to several reasons we were unable to start any fresh field trials with Vapam for the eradication of root diseases which was proposed in 1960. Such trials will be laid out in 1961 and it is hoped we will soon have some definite information on the possibility of using this soil fumigant in eradication of root disease.

Controlling root rotting Fungi: Several facultative fungal parasites cause root-rot of tea seedlings in the nursery and recently some of these fungi have been observed to affect V. P cuttings also. Control of these pathogens is sometimes feasible by incorporating fungicides into the affected soil. However, preliminary to the use of these fungicides on tea seedlings, or V. P. cuttings, it was deemed necessary to experiment on their possible phytotoxicity and a small *ad hoc* pot trial was started. Captan, PCNB and Copper oxychloride were the test fungicides and they were incorporated into the soil in which 5 month old tea seedlings were grown. Nemagon was also included in this trial with a view to determine its phytotoxic effects on tea seedling, since this nematocide is claimed to be of value in post-planting treatment of nursery beds infested with eelworm. Three seedlings per pot and 3 replications of each treatment constituted the trial. The fumigant was injected into the soil at 6" below the surface. Five months after the soil treatment, the seedlings were carefully removed and the dry weight of the roots was determined. The results were as follows:

Fungicide	Rate of application per 100 sq. feet	Mean dry weight of roots in grams per plant
Captan	$\frac{1}{4}$ lb.	1.55
	$\frac{3}{5}$ lb.	1.45
	$1\frac{1}{4}$ lb.	1.28
	$2\frac{1}{4}$ lb.	1.05
PCNB	$\frac{3}{8}$ lb.	1.66
	$\frac{3}{4}$ lb.	1.53
	$1\frac{1}{2}$ lb.	1.59
	3 lb.	1.27
	6 lb.	0.76
Copper Oxychloride	$\frac{3}{4}$ lb.	1.55
	$1\frac{1}{2}$ lb.	1.44
	3 lb.	1.06
Nemagon	$\frac{2}{3}$ pint	0.50
Control, Untreated		1.42

It is seen from the results that Captan at $1\frac{1}{4}$ lb. and $2\frac{1}{4}$ lb., PCNB at 3 lb. and 6 lb. and copper oxychloride at 3 lb. per 100 square feet decreased root development when compared to the control. These three fungicides were not phytotoxic at any of the concentrations tested and Captan at the rate of up to $\frac{3}{5}$ lb. per 100 square feet (about 260 lb./acre) and PCNB and Copper Oxychloride up to $1\frac{1}{2}$ lb. (roughly 650 lb./acre) did not adversely affect the root dry weight of the seedlings. These rates of application for the respective fungicides represent a heavy dosage and they are, therefore, not likely to adversely affect the growth of tea seedlings in soils treated to the recommended dosages of these fungicides.

Eelworm in mature tea: The field trial laid out in 1959 for the control of eelworm affecting mature tea was continued during 1960. Replicate plots were treated with Vapam at 15 and 30 gallons per acre and Nemagon at 5 and 10 gallons, injected into the soil, in June 1960 and the area supplied with 3-year old stump plants. The experiment is still under way.

Eelworm in tea nursery: A pot and field trial for the chemical control of eelworm affecting tea seedlings was laid out in March 1961. Advantage was taken of the availability of heavily infested soil in a plot under Guatemala grass for laying out the trials. The soil was potted in 14" x 12" earthenware pots and treated with nematocides. Simultaneously, 20' x 3' nursery beds were made in the eelworm affected area and the beds likewise treated with nematocides. Telone, Dowfume W-85, Fumazone, Vapam and Basudin were used in the field trial while in addition to these, formalin was also included in the pot trial. The results of these investigations will be reported in due course.

Pentachloronitrobenzene: This fungicide, commonly known as PCNB, has been found very useful as a soil fungicide in the treatment of certain root diseases, especially those caused by *Rhizoctonia*, *Sclerotium* and *Botrytis*. Our pot trials have shown that PCNB at dosages up to 650 lb./acre did not adversely affect tea seedlings. Further field experiments were laid out to study the effect of PCNB on yield and plots of 50 tea bushes (first year field) in quadruplicate were untreated and treated with PCNB at the rate of 170 lb. per acre. Preliminary yields were taken for 13 plucking rounds prior to treatment and for 28 rounds after treatment. The data (given below) obtained did not reveal any statistically significant differences in yield from the PCNB treatment. This fungicide, however, is known to produce increased yields in certain crops.

Yield in lb. of green leaf from individual plots prior to PCNB application.		Yield in lb. of green leaf from individual plots after PCNB treatment at 170 lb./acre.	
No treatment	Treatment	No treatment	Treatment
58.50	86.25	181.50	213.25
55.00	53.75	129.75	141.50
53.50	56.50	143.75	172.00
75.75	55.25	205.00	163.25
Total	242.75	660.00	690.00

Seed Treatment: The use of seed dressing to prevent losses in seed bed has been previously discussed (*UPASI sci. Dept. Tea Sect. Bull.* 11. pp. 7-8, 1953) and it was found that the beneficial effect of such seed dressings was more in directly accelerating the rate of germination of tea seeds (*Planters' Chronicle* 47: 177-181, 1952) than in reducing losses caused by moulds and bacteria. It should be mentioned, however, that mould and bacterial damage to germinating tea seeds is likely

to be greatest when either the conditions for germination are unfavourable or when the seeds are of poor quality. A trial was, therefore, laid out to test the effect of fungicide, antibiotic and mixture of antibiotic and fungicide on germination of tea seeds of low vigour collected from plants in the Experiment Station. Treatment was carried out by thoroughly shaking the seeds with a small quantity of the fungicide so that a coating of the fungicide was obtained on the seed surface. Agrimycin (containing 35.3% metallic copper, 3% streptomycin and 0.3% oxytetracycline), Tillex (containing 1.5% mercury), Captan (50% orthocide) and Allisan (2, 6-dichloro-4-nitroaniline, 4% dust) were the test chemicals. In view of the recent reports on the acceleration of water uptake, and consequently the rate of germination, by coating seeds with hydrophilic colloids, in two of the treatments the seeds were dipped in 1% agar at 37°C., without and with 3000 ppm. streptomycin. Seeds were put out for germination in the usual way and the percentage germination recorded at the end of 3, 4, 5, 6, 7 and 8 weeks was as follows:

	Control.	Agri- mycin.	Percentage germination			1% Agar.	1% Agar with strepto- mycin
			Tillex.	Captan.	Allisan.		
3 weeks	11	25	15	30	25	10	7
4 weeks	45	53	45	59	55	44	46
5 weeks	69	72	69	68	75	61	62
6 weeks	84	85	80	73	88	72	76
7 weeks	87	91	85	78	91	79	81
8 weeks	92	94	90	80	96	81	84

In the first four weeks, germination was rapid in Allisan, Captan and Agrimycin treatments when compared to the untreated control and the other treatments. In the Captan treatment, percentage germination did not increase commensurately thereafter and at the end of 8 weeks, the ungerminated seeds were found attacked by bacteria. In the Allisan and Agrimycin treatments, percentage germination was throughout higher than in the untreated control, though the difference at the end of 5 weeks and thereafter was small. It was curious that Tillex did not accelerate germination of the seeds in the present experiment as this seed dressing is known to increase the rate of germination in tea seeds. Soaking the seeds in 1% agar, with or without streptomycin, retarded germination. The results support the previous findings that certain chemical constituents in fungicides exert a hormonal effect on tea seeds and accelerate their germination. Since the percentage germination at the end of 8 weeks was very nearly the same in the untreated control as in treatments which gave accelerated rate of germination, it is concluded that no beneficial effect accrued out of the fungicide treatment in so far as control of moulds was concerned.

MISCELLANEOUS

Eucalyptus : A leaf disease of *Eucalyptus* caused by a species of *Pestalotia* was recorded. The disease was affecting young plants in the nursery, but was readily controlled by application of copper fungicides.

Coffee : Several lots of specimens of coffee plants affected by 'die-back' were examined and from the stem of all the affected plants a species of *Colletotrichum* and a bacteria were consistently isolated. The roots of the plants manifesting symptoms of typical 'die-back' were destitute of starch reserves, whereas those of unaffected plants had abundant starch content. This particular type of 'die-back' in coffee has points of similarity to that of the physiological 'die-back' in tea caused by starch deficiency. While several factors relating to either disease and pest attack or adverse growing conditions may be responsible for bringing about the depletion of starch in the roots of the 'die-back' affected coffee plants, when such plants throw out new shoots or at the time of bearing when the demands for carbohydrate supply are pressing, the plants are likely to be affected by 'die-back' owing to the lack of starch supply to the shoots.

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I thank the Central Food Technological Research Institute, Mysore, for analysing tea samples for nickel residue, the various firms who very kindly sent us samples of fungicides, chemicals and fumigants for experimentation and the managers of estates visited for their hospitality.

G. S. VENKATA RAM

Plant Pathologist

REPORT OF THE ENTOMOLOGIST

(1960 — 1961)

The Entomologist continued to stay at Arnakal Estate, Vandiperiyar, Central Travancore. The year under report was devoted almost exclusively to work on mites.

Advisory:

Letters received and despatched numbered 61 and 89 respectively. The majority of enquiries related to mites and shot-hole borer of tea, while some were on pests of shade plants, coffee and cardamom.

Touring:

18 estates in Central Travancore were visited during the year. One of these estates was visited at frequent intervals in order to make observations on flushworm trials.

MITES

Red Spider and Purple Mite were on the increase and necessitated the adoption of control measures over large areas. Scarlet Mite, which was not considered to be a very serious pest hitherto, has also assumed the status of a major pest on tea in South India.

Another mite, the Yellow Mite (*Hemitarsonemus latus*) was also noticed in one or two estates in Central Travancore. This mite is a sporadic pest, but is reported to cause considerable damage to tea in Ceylon.

Red Spider:

During the year under review there were reports of sudden increase of Red Spider in several tea districts. Details of the biology and bionomics of this mite were worked out. Red Spider was found on some alternate hosts like the shade trees, grevillea and dadap. It was also seen on roses, citrus, guava, aristolochia, red-gum and hibiscus. The presence of Red Spider on grevillea has complicated the control measures as any measures adopted in tea would not be fully effective unless attempts are also made to control the infestation on the shade trees. Attempts are being made to find out the influence of soil application of systemic acaricides.

Seasonal History: Red Spider is active and breeds on tea throughout the year. With rise in temperature, the mite population increases and generations follow in quick succession resulting in a heavy build-up of population in late March and April. It causes severe injury and the affected field looks bronzed during dry weather. During the monsoon rains, most of the active forms are washed off and in the month

of June, it might appear that the pest has disappeared. All stages of development of Red Spider, however, could be found throughout the year. At the termination of the rainy season, fresh infestations may be observed though not in serious proportions, unless ecological conditions are favourable.

Control Measures: Field trials have been conducted with a variety of acaricides and the results are being examined and will soon be published in a separate paper.

Natural enemies: Some predators were observed to attack Red Spider, namely, two Coccinellids, *Stethorus* sp. and *Scymnus* sp. and larvae and adults of Staphylinid, feeding mostly on colonies. Another predacious mite *Typhlodromus* sp. also has been observed. The Commonwealth Institute of Biological Control has taken up investigations on biological control of mites.

Purple Mite:

Observations made during the year indicated that this mite was more widespread and caused greater damage than Red Spider. Its activity appears to be limited to a short period during the dry weather, aggravating drought damage in many areas of tea. Attempts were made to work out the life history of this mite. The mite lays eggs which hatch in two to three days when the temperature is high. The newly hatched larvae are pale purplish in colour and pear shaped. This mite undergoes three moults before it becomes an adult. Each moult is followed by a short resting stage; the duration of the rest varies from a few hours to a day, depending on the prevailing temperature. The adult mite is darker than the young and has five waxy ridges on its back. The life history is completed in 12 days. Further work on the biology of this mite is being continued.

Scarlet Mite:

Scarlet Mite is usually seen on the under surface of the leaf, mostly towards the petiolar end. The life cycle of this mite is long and takes about 35 days. The details of the life history have been worked out. These mites feed near the petiole and if the attack is serious, the leaf might fall off. This mite has also been observed throughout the year. Attacked shoots have a characteristic dull reddish appearance. Even young shoots are damaged and growth is arrested. Alternate hosts, such as *Grevillea* and *Albizzia*, have been observed.

Field Trials:

Trials were carried out on a large scale to find out the comparative efficacy of various acaricides in controlling these mites.

During 1960, the following chemicals were tried, viz., Tedion, Metasystox (i), Rogor and Malathion against Red Spider and Scarlet Mite. All of them were found effective against Red Spider, but Tedion did not give a satisfactory control of Scarlet Mite. Preliminary trials on a small scale were conducted with the following acaricides against Red Spider: Kelthane, Ovotran, Eradex, Ekatin, Folidol, Mitex and Metasystox (R). All formulations were applied at a strength of 0.1%. Two applications were made, the second a fortnight after the first and population counts were made, both before and after treatment. Kelthane, Mitex and Ovotran gave excellent control, whereas Folidol, Ekatin, Metasystox and Eradex did not give the same order of control. Ekatin and Metasystox had a better residual effect. Folidol had quick action on adults, but it failed to kill the eggs effectively. It had the least residual effect. In another trial, 3 formulations were tried, viz., an I. C. I. product, Metasystox (R) and Ovotran. Metasystox (R) and Ovotran gave a more satisfactory control of Purple Mite and Red Spider than the I. C. I. product. In a separate trial on Scarlet Mite, 8 formulations were tried, viz. Akar, Ekatin, Folidol, Eradex, Metasystox (R), Kelthane, Ovotran and an I. C. I. product. These trials revealed that, though toxic to the mites, Parathion preparations like Ekatin and Folidol were not as effective as Kelthane, Akar and Ovotran.

Opportunity was available during the year to assess in a general way the relative efficiency of dust formulations of Akar (2%), Folidol (2%) and Malathion (4%), all of which gave satisfactory results.

Shot-Hole Borer:

There has been a tremendous build-up of shot-hole borer population in some estates in Central Travancore. This pest has been already recorded in this area for a number of years, dating back to the early thirties and it is now getting widely distributed. In one of the estates, it was observed that in a 24-acre pruned field more than two thousand bushes failed to recover and in another field which was skiffed, a considerable number of bushes was badly damaged. It is only at the pruning time, that the extent of damage due to shot-hole borer can be determined. In a survey of a pruned area on an estate, almost every bush had one or two branches infested with shot-hole borers. Some wood-rotting fungi also appear to lead to die-back of branches in the borer infested bushes. These fungi probably gain entry into the stem through the borer galleries and cause die-back under certain conditions.

Investigators in Ceylon have obtained some success in the control of shot-hole borer with Dieldrin. Field trials were laid out in one of the estates in South India with a view to examine the possibility of controlling this pest and die-back of branches with systemic insecticides and fungicides. Unfortunately, the results did not permit of any valid conclusion being drawn.

Flush Worm:

This pest continued to cause damage on some estates in the Central Travancore. The infestation usually commences in the month of July and the insect population starts increasing from September, reaching serious proportions during November/December. At the end of December, the pest population starts declining. The greatest damage occurs in first year fields and also in young clearings and nurseries.

Field trials were taken up in one of the estates in order to determine the efficacy of some insecticides, such as Malathion, DDT, Sevin, W. L. 1650 and Folidol. Preliminary trials revealed that DDT gave a fairly satisfactory control. In a further field trial, Folidol, Malathion and DDT gave satisfactory control, whereas Sevin and W. L. 1650 were disappointing. None of the insecticides, however, provided 100% control.

Helopeltis:

Damage by this pest was also noted during the year, and it was alleged that DDT was not effective.

Observations to-date have not revealed any evidence to suspect the failure of DDT to control the pest, although the suspicion that the insect may have developed resistance to DDT is strong in some quarters. Field trials carried out last year showed that spraying with DDT still gives a very satisfactory control. This year, some new formulations of insecticides were tested against *Helopeltis*. They were: Endrin, W. L. 1650, Sevin, Whiz, Rogor and Malathion. None of them gave satisfactory control, except W. L. 1650. DDT is still the best among the several insecticides tested so far for controlling *Helopeltis*.

Thrips:

This pest also causes considerable damage to tea. Buds and tender leaves are usually preferred to older leaves for feeding. As a result of feeding, thin brown streaks are seen on the under surface of the infested leaves. The edges of young leaves turn brown as a result of damage and the leaves themselves present an uneven surface or become curled. A severe attack causes considerable damage by stunting the growth of shoots. This year a preliminary experiment on the control of thrips was carried out with three insecticides, viz., Folidol, DDT and Dieldrin. Dieldrin and Folidol gave satisfactory control, whereas DDT did not give adequate protection. It is difficult to explain the failure of DDT to give satisfactory control of the pest, as in earlier trials it was found very satisfactory.

Scale Insects:

Damage by scale insects was observed in a very serious form in one of the estates. The species involved was *Ceroplastes* sp. The estate tried spraying with Basudin 20 E, a diazinon product, but found that this insecticide did not give satisfactory control. Gusathion, a formulation of Bayers, was tried against this scale as also a systemic insecticide, Metasystox. Metasystox failed to control the pest, but Gusathion, at a dosage of 0.2%, proved to be useful.

White Grubs:

The larval stages of cockchafer beetles were seen damaging young tea plants in new clearings. While the adult beetles feed on the leaf, the larvae bury themselves in the soil and feed on decayed vegetable matter and young roots. A preliminary trial carried out to determine the effect of a soil insecticide, viz., Aldrin dust, showed that it was effective in controlling white grubs.

Aphids:

Aphids were found to cause damage to young plants in nurseries. One application of Metasystox at a strength of 0.1% kept the plants free of aphids for a month.

White Flies on Cardamom:

There was a serious out-break of white flies on cardamom in one of the estates causing considerable damage to the plants. 2% Folidol dust was found effective in controlling the pest.

Miscellaneous:

Following are some of the minor pests which were noted during the year: *Melanagromyza* sp. (leaf miner), *Clania crameri* (Faggot-worm), *Orthacris* sp. (Grasshopper), *Homona coffearia* (Tea Tortrix), *Phassus* sp. (Borer), *Myliocerus* sp. (Grey Weevil), *Terias* sp. (Yellow butter-fly), Termites and Root-knot Eelworm.

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N. R. Ananthakrishnan,
Entomologist.

APPENDIX

THE RELATION OF INTERVAL AND RATE OF APPLICATION OF NICKEL CHLORIDE AND OTHER INORGANIC AND ORGANIC FUNGICIDES TO THE INFECTION OF TEA PLANTS BY *EXOBASIDIUM VEXANS* MASSEE

BY

C. S. Venkata Ram and V. Jayaraman

Notwithstanding the fact that blister blight control has been better achieved with copper fungicides than with any of the numerous organic formulations tested in the past (2, 5, 7, 10, 14, 17, 18), investigations were continued with new organic fungicides, chief of them being metallic salts of 2-pyridinethiol-1-oxide which have been found to give systemic disease control (1) and a formulation based on 1-chloro-2, 4 dinitronaphthalene, and inorganic fungicides with the aim in view to provide improved control measures against the disease. The performance of organic and inorganic fungicides with and without sticker was also compared.

With the spectacular results reported on the control of rusts affecting cereals (4, 8, 9, 13), sunflower (4) and mint (3) with nickel compounds, a preliminary investigation was initiated with nickel chloride to test the efficiency of nickel as a fungicide *vis-a-vis* blister blight of tea plants, the results of which have already been reported in brief (15). When it was observed that nickel gave better disease control than the conventionally employed copper fungicides, further trials with nickel chloride were laid out to study the influence of dosage and interval between applications on blister blight incidence.

MATERIALS AND METHOD

All experiments were laid out in tea fields pruned in 1959 (second year fields) in a randomized block with four replications (each of 10 bushes) per treatment. The test fungicides were sprayed with pressure retaining knapsack sprayers fitted with a low volume (T-jet) nozzle at the rate of 15 gallons of the spray fluid per acre of tea (having 2722 plants), unless otherwise stated. Spraying was carried out in the morning on the day following plucking at 7-day intervals, often in light rain but was suspended when rainfall was heavy. In the fortnightly applications, the fungicide was sprayed on the day following alternate plucking rounds. Particulars relating to the source and composition of various fungicides employed in the experiments are given in Table I.

Disease control was assessed by examining a random sample of 100 individual shoots picked from the entire crop harvested from individual plots. Percentage shoots infected by *Exobasidium vexans* in each of the treatments, mean of the four replicates, is given in Tables II to IV.

TABLE I.

Particulars of fungicides and stickers tested

Fungicide / Sticker	Composition	Source
1. Actidione-S	The Semicarbazone derivative of Cycloheximide, 1.57% active.	Upjohn Company, Kalamazoo, Michigan, U. S. A.
2. Captan	50% Orthocide, wettable powder.	Standard Vacuum Oil Co., India.
3. Copper oxychloride, Technical.	59.09 per cent. copper, metallic.	Tata-Fison Ltd., India.
4. Experimental Sticker, CR 5000/1.	Unknown.	Tata-Fison Ltd., India.
5. Cupric-Omadine	Cupric salt of 2-pyridinethiol-1-oxide.	Olin Mathieson Chemical Corporation, New York, U. S. A.
6. Ferric-Omadine	Ferric salt of 2-pyridinethiol-1-oxide.	Olin Mathieson Chemical Corporation, New York, U. S. A.
7. Gorsatox	70% wettable powder based on 1-chloro-2, 4 dinitro-naphthalene.	Tata-Fison Ltd, India.
8. Kirticopper 50-W	50% copper, metallic, as cuprous oxide.	Kirti Chemical Works, Bombay, India.
9. Kirticopper 20-W	20% copper, metallic, as cuprous oxide and 30% of an organic fungicide based on curcumin.	Kirti Chemical Works, Bombay, India.
10. Nickel chloride hexahydrate, Technical.	Laboratory reagent grade.	British Drug House, Bombay, India.
11. Oil-based copper fungicide	Copper fungicide suspended in a specially formulated oil	Standard Vacuum Oil Co., India.

Fungicide/Sticker	Composition	Source
12. OM-1763	Based on Chloracetaldehyde-2, 4-dinitrophenyl-hydrazone.	Olin Mathieson Chemical Corporation, New York, U. S. A.
13 Ortho Sticker	Unknown	Standard Vacuum Oil Co., India.
14 Perenox	50% copper, metallic, as cuprous oxide,	I.C. I. (India) Private Ltd., Madras, India.

RESULTS

In the first experiment Gorsatox, Captan with and without Ortho sticker, oil-based copper formulation, nickel chloride hexahydrate and technical copper oxychloride incorporated with Experimental Sticker CR 5000/1 were compared for field performance with that of Perenox (standard fungicide treatment) in giving disease control. All formulations were sprayed at 7-day intervals and the experiment carried out during the S. W. monsoon period. Results (Table II) showed that Gorsatox, Captan with and without Ortho Sticker and the oil-based copper fungicide did not give adequate disease control; percentage infection assessed on August 5 was so high in these treatments that spraying of these fungicides had to be discontinued. Technical copper oxychloride, which was applied at a dosage of 3 oz. of copper (metallic) per acre, when incorporated with Experimental Sticker CR 5000/1 throughout gave protection against blister blight which was statistically the same as that achieved with the standard fungicide used for comparison (Perenox at 6 oz. per acre).

Very interesting results were obtained with nickel chloride hexahydrate in the control of blister blight. During the first sampling, control achieved with Perenox was slightly better, though statistically not significant, than with nickel chloride. However, in all the subsequent samplings the situation was reversed. On two occasions, namely, in assessments made on August 19th and September 9th, nickel chloride gave significantly better disease control than Perenox.

In the second experiment the cupric, ferric and zinc salts of 2-pyridinethiol-1-oxide, referred to as cupric-, ferric- and zinc-Omadine, respectively, nickel chloride, Kirticopper 20-W and an organic fungicide based on chloracetaldehyde-2, 4-dinitrophenylhydrazone (OM-1763) were tested, all sprayed at 7-day intervals, and with the exception of nickel chloride which was sprayed at the rate of 30 gallons of fungicide fluid per acre, all others were applied at the rate of 15 gallons of spray fluid per

TABLE II.

Blister blight infection in the control (untreated) and in treatments with fungicides sprayed at 7-day intervals

Formulation and rate of application per acre.	15/7	22/7	Percentage shoots infected on				26/8	9/9	16/9
			29/7	5/8	12/8	19/8			
1. Captan, 6 oz.	29.0	33.0	39.0	75.0	—	—	—	—	—
2. Captan, 6 oz. + Ortho sticker 1½ fl. oz.	21.0	34.5	46.2	80.0	—	—	—	—	—
3. Oil-based copper, 4 pints.	30.0	25.0	39.0	62.0	—	—	—	—	—
4. Gorsatox, 6 oz.	54.0	38.4	58.2	85.0	—	—	—	—	—
5. Technical copper oxychloride 6 oz. + CR 5000/1, 3¼ lb.	13.0	11.2	17.0	37.0	39.2	34.5	15.0	20.2	16.0
6. Perenox, 6 oz.	9.0	14.0	14.5	34.0	27.2	28.2	14.0	16.2	12.2
7. Nickel chloride, 6 oz.	12.5	10.2	8.0	25.0	25.0	15.5	4.0	5.0	3.5
8. CONTROL, Untreated.	70.2	55.0	72.0	90.0	85.0	87.0	69.0	60.0	54.2
Difference required for significance $P = 0.05$	9.2	15.0	14.0	12.0	12.0	12.0	16.0	11.0	10.0

acre. The experiment was carried out during the N. E. monsoon period and results are presented in Table III.

TABLE III.

Results with fungicides obtained in Experiment 2.

Fungicide and rate of application per acre.	Percentage shoots infected on							
	17/10	7/11	14/11	21/11	28/11	5/12	12/12	20/12
1. OM-1763, 6 oz.	35.0	35.5	63.0	67.5	76.5	82.0	66.2	47.0
2. Cupric-Omadine, 6 oz.	23.0	21.0	30.0	37.2	53.0	58.5	26.0	32.0
3. Zinc-Omadine, 6 oz.	23.5	33.0	46.5	54.0	79.5	74.0	59.0	38.5
4. Ferric-Omadine, 6 oz.	28.0	17.2	47.0	44.5	65.2	59.5	55.0	39.5
5. Kirticopper 20-W, 6 oz.	27.5	33.0	54.5	48.0	62.0	61.2	38.5	45.0
6. Nickel chloride, 6 oz.	11.5	10.2	23.0	24.5	32.0	30.2	23.2	16.0
7. Nickel chloride, 3 oz.	9.2	13.2	27.5	29.0	41.2	45.0	25.2	31.0
8. CONTROL, Untreated	69.2	80.2	86.5	95.5	93.2	93.5	85.0	76.2
Difference required for significance $P = 0.05$	11.6	15.8	18.0	18.5	11.2	11.5	16.5	16.2

It was observed that OM-1763, ferric- and zinc-Omadine and Kirticopper 20-W, all applied on weekly rounds at the rate of 6 oz. in 15 gallons of water per acre per round, gave poor control against blister blight (Table III). Cupric-Omadine gave satisfactory protection and percentage disease control achieved with this fungicide sprayed at 6 oz. per acre was statistically the same as that obtained with nickel chloride at the same concentration in 6 out of the 8 assessments. Nickel chloride at 3 oz. per acre was as effective as at 6 oz. in controlling blister blight, the difference in percentage infection in the two treatments being insignificant in all but one sampling (Table III).

The excellent disease control achieved with nickel chloride (Table II and III) logically led to an experiment to investigate the control likely to be obtained by the application of this fungicide on longer rounds. In Experiment 3 nickel chloride at 6 oz. in 30 gallons per acre was applied at 7- and 14-day intervals and in parallel treatments Kirticopper 50-W, containing 50% copper as cuprous oxide, was sprayed at 6 oz. in 15 gallons per acre. In two other treatments Actidione-S at 10 and 40 ppm. was sprayed at 15 gallons per acre on weekly rounds. The experiment was carried out during the N.E. monsoon and results are included in Table IV. Kirti-

copper 50 W gave adequate disease control when applied at 7- or 14-day intervals, the difference in percentage infection in the two treatments being not significant in 6 out of the 7 samplings. In contradistinction, nickel chloride applied at 14-day intervals did not give adequate protection and in this treatment percentage blister blight infection was significantly higher than in the 7-day round treatment. On 7-day rounds and at the same rate of application, both nickel chloride and 50% cuprous oxide (Kirticopper 50-W) gave statistically the same disease control throughout.

TABLE IV.
Giving results obtained with fungicides applied at weekly and fortnightly intervals in Experiment 3.

Fungicide and rate of usage per acre.	Spraying round	Percentage shoots infected on							
		14/10	11/11	18/11	25/11	2/12	9 12	16 12	
1. Actidione-S 10 ppm.	7-day	44.2	56.0	71.2	69.5	58.0	74.0	56.2	
2. Actidione-S 40 ppm.	7-day	35.0	44.0	55.0	61.0	38.2	54.2	43.5	
3. Kirticopper 50-W, 6 oz.	7-day	15.5	10.5	25.0	29.5	31.0	30.5	23.5	
4. Kirticopper 50-W, 6 oz.	14-day	25.0	27.5	33.0	46.0	35.0	35.0	32.0	
5. Nickel chloride, 6 oz.	7-day	12.5	19.2	30.2	23.0	15.5	26.0	19.0	
6. Nickel chloride, 6 oz.	14-day	30.0	26.0	51.0	46.0	38.0	49.0	32.0	
7. Control, Untreated		68.5	72.0	82.0	88.5	82.5	87.0	59.2	
Difference required for significane, $P=0.05$		12.2	13.0	17.2	20.8	19.0	15.0	15.4	

DISCUSSION

In the first experiment the influence of stickers on the field performance of organic and inorganic fungicides *vis-a-vis* blister blight control was investigated. The addition of Ortho sticker to Captan did not improve the performance of the fungicide (Table II) and these results are in agreement with those on stickers obtained earlier (6). Investigations in Ceylon (18) have shown that 4 oz. of copper oxychloride plus 2 oz. of a sticker did not give better results when compared to other fungicides without the addition of the same sticker; generally the incorporation of stickers with pure copper oxychloride did not improve the performance of the fungicide (12). Earlier results obtained here (A.R. UPASI sci. Dep. Tea Sect., for 1957-58, pages 16-19) have shown that proprietary copper fungicides and an organic copper compound with and without sticker gave similar protection against blister blight.

In the present trial with the experimental sticker CR 5000/1 at the rate of $3\frac{1}{4}$ lb. per 6 oz. of copper oxychloride in 15 gallons of water per acre per round, disease control achieved was the same as with Perenox without a separate sticker. From this and the other data mentioned in the foregoing it seems unlikely that the incorporation of a separate sticker with a good proprietary fungicide, or even pure copper oxychloride as observed in certain instances (12), would improve the performance of the fungicide.

None of the organic metallic fungicides tested gave blister blight control which was equal to that achieved with either proprietary 50% copper fungicides or nickel chloride. Only one organic formulation, i.e., cupric salt of 2-pyridinethiol-1-oxide (cupric-omadine), gave adequate protection. It was interesting to note that while the cupric salt gave satisfactory protection, the ferric and zinc salts of 2-pyridinethiol-1-oxide gave poor disease control. Obviously the copper moiety in the cupric-omadine fungicide seems to have played an active part in giving protection against blister blight. In previous investigations, organic manganese (5), zinc (2,14) and ferric (2) compounds (carbamates) did not give satisfactory results against blister blight, and here also the zinc and ferric salts of 2-pyridinethiol-1-oxide failed to give adequate disease control (Table III). Derivatives of 2-pyridinethiol-1-oxide have exhibited systemic activity in cucumber and broadbean plants and controlled foliar diseases (1) but the three formulations tested in the present trials did not equal in performance to that of 50% copper fungicides. The two non-metallic organic fungicides, namely Gorsatox (based on 1-chloro-2,4 dinitronaphthalene) and OM-1763 (based on chloroacetaldehyde-2,4-dinitrophenylhydrazine) gave little protection against blister blight, whilst the antibiotic Actidione-S also failed to give satisfactory results at the concentrations tested. In results recently obtained (17), Actidione-S was found ineffective against the disease when sprayed at 14-day intervals, at concentrations upto 50 ppm. It may be pertinent to observe here that, while in the case of many horticultural crops organic fungicides have given excellent protection against several diseases against the blister blight disease of tea plants no straight organic fungicide tested so far (2, 5, 7, 10, 14, 17, 18) has surpassed the field performance of copper formulations. Zineb (zinc ethylene bisdithiocarbamate) at 1.2 lb./acre gave results equal to that secured with copper fungicides (14) and Agrimycin 500 was effective against blister blight, particularly on extended rounds of application when it surpassed the performance of straight copper formulation (17). However, the two formulations of Agrimycin which were tested, contained in addition to Streptomycin and Oxytetracycline 35.2% and 42.4% copper (metallic), respectively. It would, then, appear that the superior performance of these to that of straight copper fungicides, on longer spraying rounds, resulted from the antibiotics synergizing the action of copper. Agrimycin 500 containing less copper and more of antibiotics was superior to that which had more copper content and less of the anti-

biotics. But generally antibiotics by themselves have not indicated very promising results, though one formulation, i.e., Actispray (Cycloheximide), was shown to give adequate blister blight control (17). While the range of organic fungicides so far tested against blister blight is quite impressive, it is perhaps in the fitness of scientific inquiry necessary to continue attempts in the direction of finding a suitable organic formulation which would excel the commonly employed copper fungicides in field performance.

Spectacular results were obtained with nickel chloride sprayed as a fungicide for blister blight control (Table II and III). As already reported (15), 3 oz. of nickel chloride applied on 7-day rounds to plots with an average initial infection of 84% reduced the disease to 24% and 13% after 3 and 5 weeks, respectively, whereas in a parallel treatment with 6 oz. of copper oxychloride the infection was 80% and 40%, respectively. Nickel chloride hexahydrate, which was employed in all the tests, contained only 25% nickel as metallic while the cuprous oxide and copper oxychloride fungicides had 50% copper, metallic. As seen from Table II, nickel chloride was superior to cuprous oxide (Perenox) in controlling blister blight when both were sprayed on 7-day rounds at 6 oz. of the fungicide per acre per round. At this concentration, only 1.5 oz. of nickel as against 3 oz. of copper were applied. In the second Experiment (Table III), nickel chloride at 3 oz. per acre (0.75 oz. nickel) gave statistically the same disease control as at 6 oz. (1.5 oz. nickel). Clearly, these observations as well as those reported recently (15) indicate further experimentation with nickel salts, both organic and inorganic, against the blister blight disease of tea.

Venkata Ram (unpublished) has demonstrated the eradivative action of nickel on *Exobasidium vexans*, a finding supported by field observations on the disease control achieved with the fungicide (15). From the results obtained here (Table IV), it would seem that nickel chloride has poor residual action because in applications at 14-day intervals, while this fungicide gave very poor disease control, the conventional copper fungicide gave protection comparable to that achieved on 7-day rounds. In the case of cereal rusts, nickel compounds have given good results both as eradicants as well as protectants (4, 8, 9, 13), while similar results were also obtained with nickel fungicides against sunflower (4) and mint (3) rust fungi. Against blister blight, probably other nickel compounds may prove to be better eradivative and protective fungicides than nickel chloride and only further work will provide an answer to this question.

SUMMARY

1. Field trials were carried out in 1960 with inorganic, organic metallic and organic non-metallic fungicides against the blister blight disease of tea plants.

2. The two organic non-metallic fungicides, OM-1763 (based on chloroacetaldehyde-2,4-dinitrophenylhydrazine) and Gorsatox (1-chloro-2,4-dinitronaphthalene) gave unsatisfactory results.

3. Out of the three metallic salts of 2-pyridinethiol-1-oxide, only the formulation containing copper (cupric-omadine) gave adequate blister blight control; the ferric and zinc salts were unsatisfactory.

4. Spectacular results were obtained with nickel chloride at 6 oz. and 3 oz. of the fungicide per acre, 1.5 oz. and 0.75 oz. nickel, respectively, and it was observed that the action of nickel on *Exobasidium vexans* was that of an eradicator. Metal to metal, nickel at half the concentration of copper gave disease control superior to that achieved with copper fungicide on 7-day round applications.

5. Cuprous oxide (Kirticopper 50-W) at 6 oz. of the fungicide per acre again gave satisfactory disease control when the interval between applications was extended to 14-days. On extended rounds nickel chloride proved unsuitable, indicating poor residual action.

6. When a tea area is severely attacked by blister blight, the disease can be sooner controlled with nickel chloride at application on 7-day rounds than with copper fungicides.

REFERENCES

- | | |
|---|---|
| (1) Cohen, S. I.,
Reinhart J. H.
and Ristich, S. S. | (1960) Systemic disease control by 2-pyridinethiol-1-oxide and its derivatives. <i>Phytopath.</i> 50 : 239. |
| (2) De Wille, G. A. | (1960) A treatise on chemical control of blister blight. <i>Arch. Tea Cult.</i> 20 (1), 44 pp. |
| (3) Farkas, G. I.,
Molnar G., and
Kiralay, Z. | (1960) Control of the mint rust fungus, <i>Puccinia menthae</i> , by nickel salts. <i>Phytopath.</i> 50 : 866. |
| (4) Forsyth, F. R., and
Peturson, B. | (1959) Chemical control of cereal rusts, IV. The influence of nickel compounds on wheat, oat and sunflower rusts in the green house. <i>Phytopath.</i> 49 : 1-3. |
| (5) Jayaraman, V., and
Venkataramani, K. S. | (1957) Control of blister blight of tea in Southern India - The 1956 field trials. <i>Planters' Chronicle</i> 52 : 35-39. |

- | | |
|---|---|
| (6) Jayaraman, V., and Venkata Ram, C. S. | (1959) Control of blister blight of tea in Southern India - The 1958 field trials. <i>A. R. UPASI sci. Dep. Tea Sect. for 1958-1959</i> , pp. 28-35. |
| (7) Johnston, A. | (1953) Blister blight of tea in Malaya, 3. Results of further spraying experiments. <i>Malayan agric. J.</i> 36 : 81-88. |
| (8) Keil, H. L., Frohlich, H. P., and Van Hook, J. O. | (1958) Chemical control of cereal rusts, I. Protective and eradivative control of rye leaf rust in the green house with various chemical compounds. <i>Phytopath.</i> 48 : 652-655. |
| (9) Keil, H. L., Frohlich, H. P. and Glassick, C. E. | (1958) Chemical control of cereal rusts, III. The influence of nickel compounds on rye leaf rust in the green house. <i>Phytopath.</i> 48:690-695. |
| (10) Laoh, J. Ph. | (1955) Fungicidenproeven bij blister blight (<i>Exobasidium vexans</i>) op thee. <i>Arch. voor Theecult.</i> 19 (1) : 1-9. |
| (11) Loos, C. A. | (1950) Crop protection during plucking. <i>Tea Quart.</i> 21 (4) : 16-21. |
| (12) Mulder, D. | (1960) The use of separate stickers in blister blight fungicides. <i>Tea Quart.</i> 31 : 12. |
| (13) Peturson, B., Forsyth, F. R. and Lyon, C. B. | (1958) Chemical control of cereal rusts, II. Control of leaf rust of wheat with experimental chemicals under field conditions. <i>Phytopath.</i> 48:655-657. |
| (14) Pfaeltzer, J. W. | (1951) Studies in blister blight control, IV. An evaluation of some commercially available fungicides for the control of blister blight. <i>Tea Quart.</i> 22 : 52. |
| (15) Venkata Ram, C. S. | (1961) Application of nickel chloride to tea plants (<i>Camellia sinensis</i>) and control of blister blight. <i>Curr. Sci.</i> 30 : 57-58. |
| (16) Venkata Ram, C. S., and Jayaraman, V. | (1959) The relation of interval between fungicide application to the control of blister blight disease of tea plants. <i>A. R. UPASI sci. Dep. Tea Sect. for 1958-1959</i> , pp. 36-41. |

- (17) Venkata Ram, C. S.,
and Jayaraman, V.
- (1960) The relationship of interval and rate of application of antibiotics, copper and organic fungicides to the infection of tea plants by *Exobasidium vexans* Massee. A. R. UPASI sci Dep. Tea Sect. for 1959-1960, pp. 36-48.
- (18) Visser, T.,
Shanmuganathan, N.,
and Sabanayagam, J. V.
- (1958) Blister blight control in 1957 with respect to fungicidal formulation, application rates and yield. *Tea Quart.* 29 : 9-20.

THE EFFECT OF INTERVAL BETWEEN FUNGICIDE APPLICATIONS TO TEA PLANTS ON BLISTER BLIGHT AND YIELD

BY

C. S. Venkata Ram

That the chief aim in blister blight protection is to achieve disease control from the point of economy of cost, time and labour, of course within the framework of safeguarding the health of the plant, is stressing the obvious. Venkata Ram and Jayaraman (6) testing several copper fungicides observed that cuprous oxide, but not copper oxychloride, gave disease control which was significantly not different whether the fungicide was sprayed at 7- or 10-day intervals and quite often even when applied at 14-day intervals. The same authors again obtained good results with two cuprous oxide fungicides and a formulation containing copper and antibiotics in synergistic combinations, on extended rounds of application (7). These results confirmed the findings of other workers (2, 4) who had earlier indicated the possibilities of increasing the interval between fungicide applications upto 14 days. While several reports now exist on blister blight incidence as influenced by the periodicity of fungicide application, some indicating the virtues of longer (10- to 14-day) rounds on the basis of saving in cost of spraying and others of shorter (weekly) rounds on the basis of reduced infection resulting therefrom, while yet others decidedly recommending 3-4 day rounds (1), very little is known about the crop response to fungicide application at different intervals *vis-a-vis* blister blight control. Even when the infection resulting from application of a fungicide at longer intervals were to be comparable to that in the treatment at shorter intervals, the conclusion that longer rounds of application could be recommended would at best be *a priori* without taking into consideration the resulting effect of the treatment on the yield. Crop yield in tea as influenced by blister blight and its control with fungicide sprayed on 7-, 10- and 14-day rounds has been the subject of study in the present investigation.

MATERIALS AND METHOD

Perenox (a proprietary fungicide containing 50% copper, metallic, as cuprous oxide), was sprayed at the rate of 6 oz. in 15 gallons of water per acre with pressure retaining knapsack sprayers. There were three treatments each with six replications, randomized and each replicate plot had 20 x 12 tea bushes (approximately 1/12 acre). The area under treatment was selected in a field where blister blight incidence is normally severe. Spraying was carried out at 7- (short round), 10- and 14-day (long rounds) intervals and in the case of 7- and 14-day rounds on the day following plucking at weekly intervals, whereas on the 10-day rounds certain number

of applications were made between plucking rounds. The crop harvested every week from individual plots was recorded and from the total number of pluckable shoots obtained in a plot, two random samples of 100 each were examined for blister blight infection. Any shoot with either one or more of translucent infection spots or well defined blisters was considered infected. The average infection in each sampling in the three treatments is given in Table I.

RESULTS

Blister blight infection was moderate to high in all the treatments almost throughout the experiment. This is accounted for partly by the disease proneness of the area under treatment, partly by spraying done by estate labour and partly by the severity of disease evaluation. As the main purpose here was to determine whether or not application on extended rounds would give economic control of blister blight when spraying was done by estate labour, it is deemed that the test conditions required in the present investigations have been met.

When the spraying was carried out on 10-day rounds the percentage infections was statistically the same as that on 7-day rounds in 10 out of the 14 assessments (Table I.) Only in 5 samplings blister blight disease in the 10-day round treatment was 5% over that in the 7-day round treatment and in no case did the difference reach 10%. The protection given by application at 10-day intervals is considered as satisfactory.

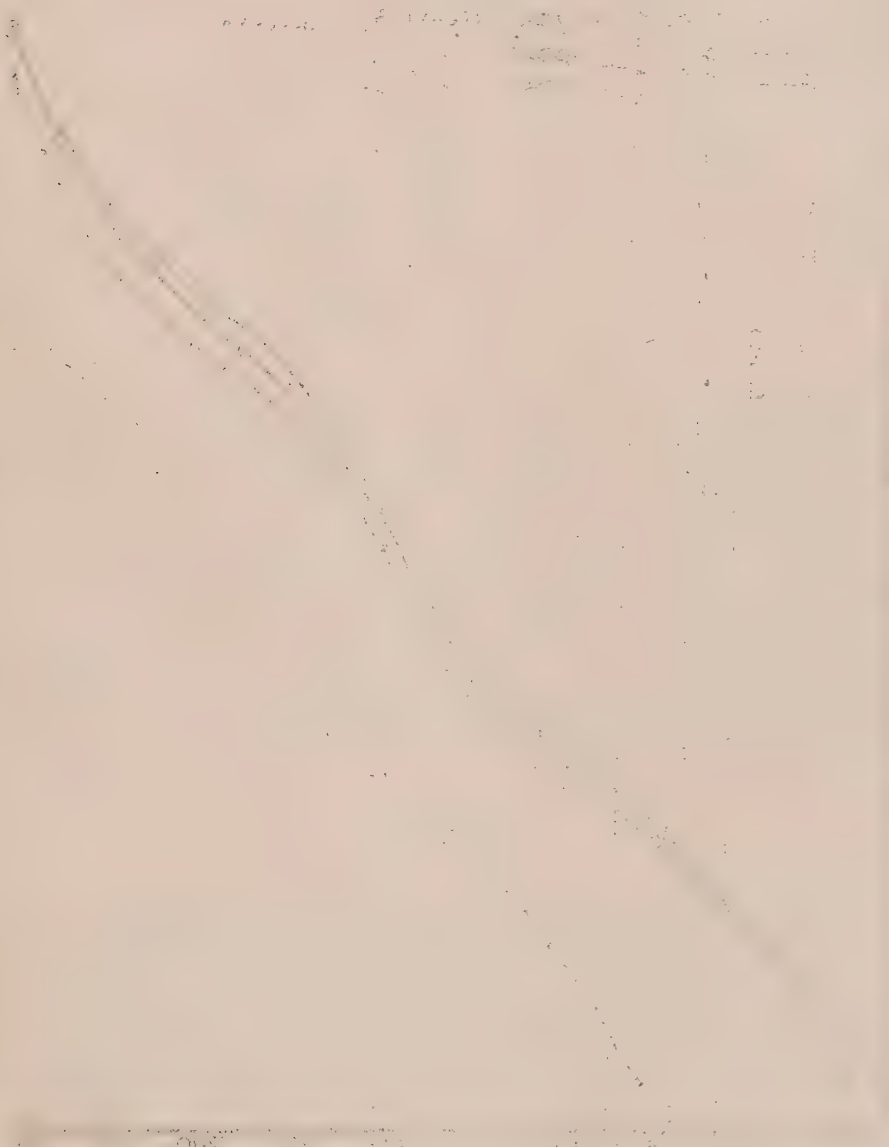
Application at 14-day intervals gave blister blight control which was not significantly different from that achieved with spraying at 7-day intervals in 8 out of 14 assessments. Here again the disease was generally from 2% to 5% more in the treatment on longer round than in the shorter one and exceeded 10% only on two occasions. When applications on the two longer rounds were compared, it was found that the difference was significant in only 4 out of the 14 samplings.

The crop harvested from individual plots in the three treatments from July 6th to November 9th, 19 plucking rounds, is given in Table II and Fig. 1. Yield of tea (green leaf) in the 7-day round treatment was the highest, closely followed by that in the 10-day round treatment, whereas crop in the 14-day round treatment was the lowest and appreciably less than in the other two treatments (Table II). However, the differences in crop in the three treatments were not significant.

TABLE I.

Percentage shoot infection at weekly assessments in plots sprayed with Perenox at 7-, 10- and 14-day intervals.

Treatment	July 6	July 13	July 20	July 27	Aug. 3	Aug. 10	Aug. 24	Aug. 31	Sept. 7	Sept. 14	Oct. 12	Oct. 20	Oct. 26	Nov. 2
1. 7-day round	26.8	8.5	37.6	38.0	58.3	56.5	39.0	17.2	16.0	33.5	49.0	21.0	13.2	16.3
2. 10-day round	35.2	13.0	44.2	35.7	58.0	66.3	43.5	19.7	21.7	38.3	56.5	25.3	14.8	21.0
3. 14-day round	34.3	14.7	39.8	42.3	71.3	66.0	49.7	19.0	20.2	39.0	54.5	28.3	18.8	20.5
Significant or not	Yes	No	No	Yes	Yes	Yes	Yes	No	Yes	No	No	Yes	No	No
C. D. (P = 0.05)	3.4	—	—	4.7	8.5	4.9	4.7	—	2.4	—	—	2.0	—	—



PERCENTAGE OF ...

1.1

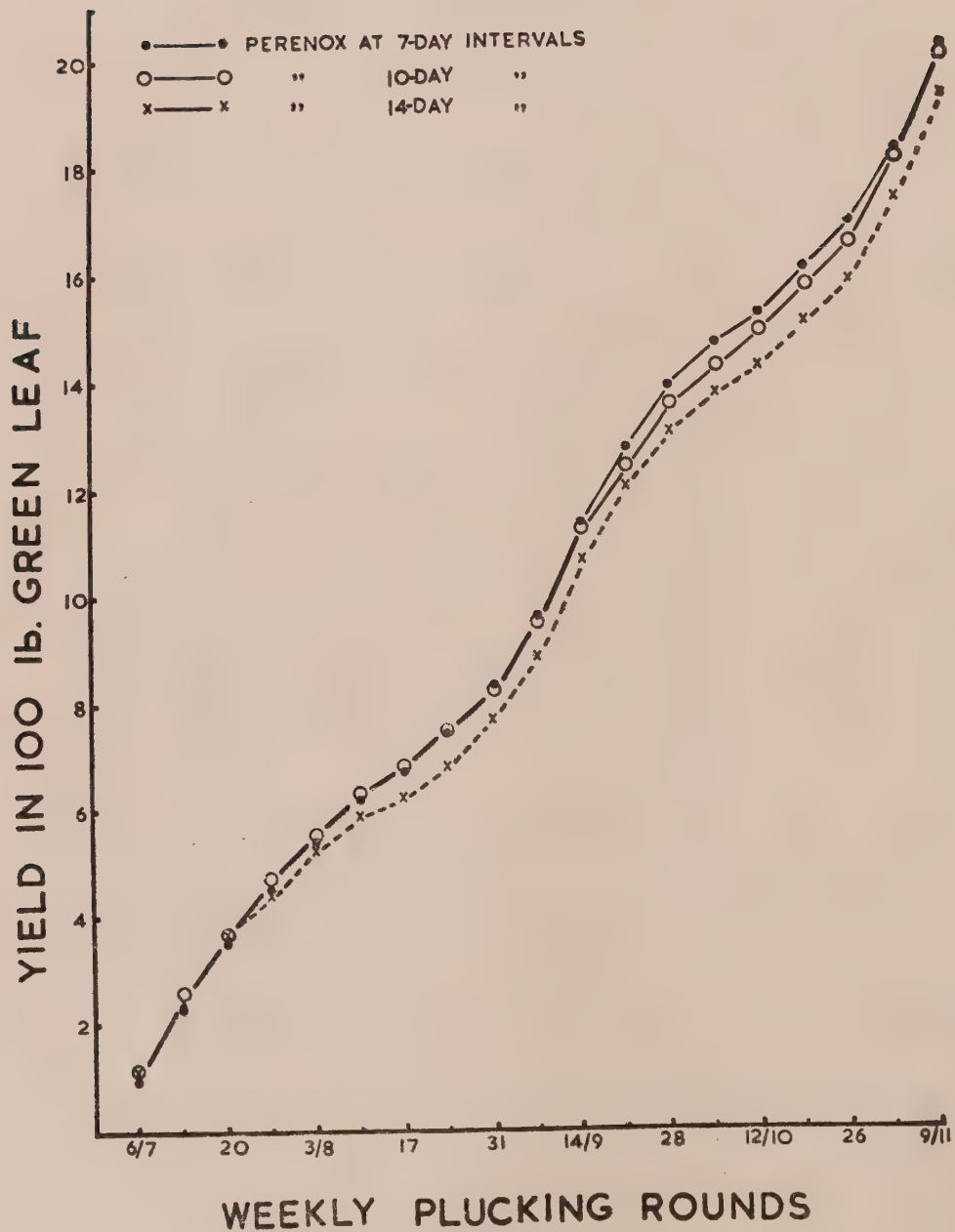


Fig. 1

TABLE II.

Crop yield in lb. green leaf in individual plots sprayed at 7-, 10- and 14-day intervals for 19 weekly plucking rounds.

Treatments	Plots						Total per treatment
	1	2	3	4	5	6	
7-day round	455	337	264	302	336	322	2016
10-day round	394	421	391	219	303	278	2006
14-day round	304	446	305	322	285	261	1923

Significant or not : Not significant.

It is seen from Fig. 1 that the crop yield in the three treatments was comparable during the first 4 harvests, i. e., from July 6th to 27th. Thereafter the yield in the 14-day round treatment started declining considerably when compared to yield in the other two treatments and in the eighth harvest on July 24th the yield in the 14-day round treatment was 67 lb. less than in the 7-day round treatment. The yields in the 7- and 10-day round treatments were comparable in the first 11 plucking rounds but subsequently a slight diminution in yield was observed in the 10-day round treatment. From Table I and Fig. 1 it is seen that the period in which crop decline was noticed in the 14-day round treatment was correlated with heavy blister blight incidence. Thus, it would appear that crop loss did occur consequent on heavier infection in plots which were sprayed on fortnightly rounds in comparison to weekly rounds.

DISCUSSION

Loos (4) in Ceylon worked out the reduction in the cost of disease control achieved when fungicide application was carried out at 14-day intervals. He found that in 1949 with 29 applications on weekly rounds the crop increase was only 4 lb. made tea per acre over the yield obtained when only 15 fortnightly applications were made, the economics of control being decidedly in favour of the latter treatment. In 1950, Loos observed that the increase in yield resulting from 30 weekly over that of 16 fortnightly applications was 37 lb. per acre, but here too there was economy of labour and time while the gain in crop in the treatment on weekly rounds was just offset by the higher cost of spraying. In the present investigation the yield in green leaf in the fungicide treatment at 7-day intervals was higher by 93 lb. than that in treatment at 14-day intervals (Table II). Taking this figure to be the equivalent of 23 lb. of made tea, the increase in crop accruing out of weekly applications over that of fortnightly ones is approximately 46 lb. of made tea per

acre (23 lb. being for 6 plots each of about 1/12 acre), comparable to the figure obtained by Loos (4) in his 1950 experiments. It must be mentioned, however, that the difference between yields in treatments at 7-, 10- and 14-day intervals was not significant. Also, the tea area selected for the present experiment was in the second year and prone to heavy infection, i. e., the trial was carried out under extremes of condition. Nonetheless, the fact that appreciable loss in crop resulted from spraying on 14-day rounds and that the period of maximum decline in yield (Fig. 1) coincided with the period when blister blight incidence was heavy (Table I) calls for caution in advocating a spray schedule of 14-day rounds.

In the previous plot trials carried out here (6, 7) formulations based on 50% cuprous oxide gave protection against blister blight which was statistically the same whether the fungicide was sprayed at 7- or 10-day intervals and on most occasions also at 14-day intervals. The difference in the percentage infection in the 7- and 10-day round treatments was insignificant ten times out of fourteen and that between 7- and 14-day round treatments on eight occasions (Table I). These results compare favourably with previous findings (6, 7). On the basis of percentage blister blight infection and the insignificant differences in crop in the three treatments (Table II), one would be tempted to recommend a 14-day round schedule of spraying against blister blight. But a critical evaluation of the data on crop obtained in the three treatments (Fig. 1) does not allay the doubt whether a 14-day schedule would be economical in view of the appreciable crop loss resulting therefrom, concomitant with heavy blister blight incidence. Probably such losses may be small in one year and comparatively large in another as shown by Loos (5). The incidence of blister blight may also vary, depending on field facing, shade and the year from pruning. Johnston (3) has pointed out that in tea recovering from pruning considerably more stalk infection occurred when plants were sprayed at 14-day intervals than on 7-day rounds.

That spraying at 10-day intervals with a good 50% cuprous oxide fungicide would undoubtedly give disease control equal to that achieved with applications at 7-day intervals is unquestionable, both from the point of view of protection against the actual blister infection, which was obtained here (Table I) and in the previous plot trials (6, 7), as well as that of crop, which in the treatment was only 10 lb. of green leaf less than in the 7-day round treatment (Table II). Only 12 applications at 10-day as against 18 on 7-day intervals were made, meaning 6 rounds less at a saving of approximately Rs. 12/- for the loss of 20 lb. of green leaf or 5 lb. of made tea per acre. This indicates that spraying at intervals of 10-days was more economical than at 7 days. However, the same cannot be said of spraying at 14-day intervals. Although the statistical interpretation of the crop loss in the 14-day round treatment, compared to that in the 7-day round, was that it was due to reasons other than the treatment since the differences were insignificant (Table I), there was a marked reduction in crop beginning at a period when the blister blight infection was heavy and the decline in yield continued over several weeks (Fig. 1). At the end of

the experiment the 14-day round treatment was down by 93 lb. when compared to 7-day round, a loss of 186 lb. of green leaf or approximately 46 lb. of made tea per acre for the saving of 9 rounds.

In conclusion it may be stated that if a good cuprous oxide fungicide is used, spraying at 10-day intervals is likely to be more economical than spraying at 7-day intervals, whereas on 14-day rounds it may be uneconomical. While the disease control achieved by fungicide spraying at 14-day intervals was previously considered adequate from the point of view of protection against infection (6, 7) it is now considered inadequate from the point of view of crop loss.

SUMMARY

1. The yield of tea and blister blight infection in plots sprayed with Perenox at 7-, 10- and 14-day intervals was recorded over a period of nineteen weeks in 1949.

2. When compared to spraying at 7-day intervals, disease control in the 10- and 14-day treatments was statistically the same in ten and eight out of the fourteen assessments, respectively.

3. Differences in crop obtained in the three treatments were not significant when analysed statistically. However, a critical evaluation of data on crop returns from the three treatments revealed that appreciable losses occurred when spraying was done at 14-day intervals, but not at 10-day intervals, compared to the yield in the 7-day round treatment. The decline in yield was coincidental with heavier blister blight infection.

4. Spraying Perenox at 10-day intervals will be more economical than spraying on 7-day rounds while at 14-day intervals it is likely to be uneconomical, especially in tea in the second year from pruning. Whether it will be economical in tea in the third and fourth year from pruning can only be determined by further trials.

ACKNOWLEDGEMENT

I am thankful to Sri S. Ananda Rau and Sri V. Jayaraman for the stimulating discussions on the subject of this paper and for their criticisms. The willing co-operation and facilities received from the management of Daverashola Estate in carrying out this trial is gratefully acknowledged. Thanks are also due to Messrs. Imperial Chemical Industries (India) Private Ltd., for making available the stock of Perenox used in the trial.

REFERENCES

- | | |
|---------------------|---|
| (1) De Wille, G. A. | (1960) A treatise on chemical control of blister blight. <i>Arch. Tea Cult.</i> 20 (1), 44 pp. |
| (2) Hainsworth, E. | (1949) Proceedings of the First Symposium on blister blight control. The position in N. E. India. <i>Tea Quart.</i> 20 (3 and 4) : 119-122. |

- | | |
|---|---|
| (3) Johnston, A. | (1953) Blister blight of tea in Malaya, 3. Results of further spraying experiments. <i>Malayan agric. J.</i> 36 : 81-88. |
| (4) Loos, C. A. | (1950) Crop protection during plucking. <i>Tea Quart.</i> 21 (4) : 16-21. |
| (5) Loos, C. A. | (1954) Report of the Pathological Division for the year 1952. <i>Tea Res. Inst. of Ceylon Bull.</i> 34 : 40-41. |
| (6) Venkata Ram, C. S.
and Jayaraman, V. | (1959) The relation of interval between fungicide application to the control of blister blight disease of tea plants. <i>A. R. UPASI sci. Dep. Tea Sect. for 1958-1959</i> , pp. 36-41. |
| (7) Venkata Ram, C. S.
and Jayaraman, V. | (1960) The relationship of interval and rate of application of antibiotics, copper and organic fungicides to the infection of tea plants by <i>Exobasidium vexans</i> Masee. <i>A.R. UPASI sci. Dep. Tea Sect. for 1959-1960</i> , pp. 36-48. |

BUD - BREAK IN PRUNED TEA BUSHES IN RELATION TO POSITION AND TREATMENT OF THE BRANCHES

K. S. Venkataramani

It is a customary practice to clean the frame-work of pruned tea bushes of moss and lichen, whenever these epiphytic growths are present. For this purpose, a dilute solution of caustic soda (2%) is generally used; but owing to the difficulty in handling this chemical, alternative bark washes have been tried and employed in recent years. It is also believed that a judicious application of caustic soda wash helps in softening the bark and in early and better bud-break. However, it is not clear whether this effect is due to the removal of the heavy growths of epiphytes or directly due to the softening of the bark.

Results of experiments carried out hitherto have been conflicting. de Jong (1951) reported that no significant difference could be found in bud-break in untreated bushes and those treated with several bark-washes. In Ceylon, Portsmouth (1952) found that lime wash gave the best results producing more number of new buds per bush than any of the other treatments tried. In one of our experiments, it was realised that the effects of treatments were difficult to assess with any degree of accuracy, but indications from observations of a subjective nature were that caustic soda at 2% strength was better than any other bark wash tried in the removal of moss and lichen. No clear indication, however, was forthcoming to suggest that any of the bark-washes had an effect in promoting bud-break and it was considered that it was governed mainly by the inherent vigour of the bush (Venkataramani, 1951). To eliminate variations due to bush vigour it is desirable to select uniform bushes and to test two or more treatments on one and the same bush which would provide two or more identical branches; and it is only thus that some reasonable conclusion could be drawn on the effects of bark-washes on bud-break. It is also likely that the position of the branch in the bush may have some influence on bud-break and this is also to be taken into consideration. With these in view a small, but critical, experiment was planned at the Tea Experiment Station, Devvarshola in April 1960 and the results are presented in this paper.

MATERIALS AND METHODS

In a small compact plot of tea bushes (age 32 years from planting; jat 'Nellimunda'), ten bushes free from moss and lichen were selected at random by eye-judgement for uniformity at the time of pruning. The bushes were all pruned to 60 cm. In each such bush, twelve identical branches (10 cm. long; 8 mm. average diameter), six in the centre and six on the periphery, were chosen for the following treatments :

A — Lime wash (10% suspension)

B — Caustic soda solution (2%)

C — Control (untreated)

D — Euphytan (5% emulsion)

E — Euphytan (10% emulsion)

F — Sandolin 'A' (0.75% solution)

The experimental branches were swabbed with the respective chemicals taking care to prevent excessive application, and each treated branch was suitably labelled. The treatments were repeated both in the central and peripheral branches, and thus all treatments were done on the same bush. The ten bushes formed the ten replications. Only one application was made within the first week of pruning. Bud and shoot counts in each branch were made 45 and 150 days after pruning, the second count being made at the final 'tipping' time.

EXPERIMENTAL RESULTS AND CONCLUSIONS

TABLE I

Average number of buds produced on each branch 45 days after pruning

Position \ Treatment	Treatment						Mean
	A	B	C	D	E	F	
Centre	3.70	4.20	3.20	3.10	3.00	3.00	3.37
Periphery	2.80	3.00	2.70	2.90	2.50	2.30	2.70
Mean	3.25	3.60	2.95	3.00	2.75	2.65	3.03

(i) position = 0.27

C.D. at 5% for (ii) treatment = 0.46

(iii) interaction = 0.65

The effects due to position and treatments are highly significant.

The average number of buds produced in the centre is significantly greater than that produced in the periphery of the bush.

Treatment B (2% caustic soda wash) has produced significantly more number of buds than the untreated control or treatments E and F. However, there is no significant difference between treatments A and B, and A and D.

With treatments A, B and F, the bud-break is more in the central branches than in the peripheral ones.

In the central position, treatment B is significantly superior to the other treatments.

TABLE 2

Average number of buds produced on each branch 150 days after pruning

Treatment Position	A	B	C	D	E	F	Mean
Centre	7.20	7.90	5.90	5.90	6.30	5.70	6.48
Periphery	6.00	7.10	5.90	6.30	6.20	5.50	6.17
Mean	6.60	7.50	5.90	6.10	6.25	5.60	6.32

$$(i) \text{ treatment} = 0.73$$

$$\text{C. D. at 5\% for } (ii) \text{ position} = 0.42$$

$$(iii) \text{ interaction} = 1.03$$

The effect of the treatments is highly significant. The mean number of buds at the final examination for treatment B (caustic wash) is significantly higher than that for the other treatments. The variables due to position and interaction are not significant.

The centre gives numerically more number of buds than the periphery, although this difference is not statistically significant.

The pooled analysis of the observations made at the two time intervals (45 and 150 days) shows that the effect due to treatments, positions and time are highly significant, while none of the interactions is significant. Examining the data for treatment, time and position effects, the results may be summarised as follows :

TABLES 3 & 4.

Pooled average number of buds per branch (Treatment and Position, and Treatment and Time effects)

Treatment Position	A	B	C	D	E	F	Mean
Centre	5.45	6.05	4.55	4.50	4.65	4.35	4.92
Periphery	4.40	5.05	4.30	4.60	4.35	3.90	4.43
Mean	4.92	5.55	4.43	4.55	4.50	4.12	4.68

Treatment Time	A	B	C	D	E	F	Mean
45 days	3.25	3.60	2.95	3.00	2.75	2.65	3.03
150 days	6.60	7.50	5.90	6.10	6.25	5.60	6.33
Mean	4.92	5.55	4.43	4.55	4.50	4.12	4.68

	(i) Treatment	=	0.43
	(ii) Position	=	0.25
	(iii) Treatment X Position	=	0.61
C.D. at 5% level for	(iv) Time	=	0.25
	(v) Treatment X Time	=	0.61

Treatment B gives significantly greater number of buds than all other treatments. The centre is superior to the periphery in bud production. Treatments A and B have produced more number of buds in the central branches than in the peripheral ones.

As expected, the number of buds produced after 150 days is more than that produced during the first 45 days.

TABLE 5

Pooled average number of buds per branch
(Position and Time effect)

Position Time	Centre Periphery		Mean
45 days	3.37	2.70	3.03
150 days	6.48	6.17	6.33
Mean	4.92	4.43	4.68

C. D. at 5% for Position X Time = 0.35

During the first period of 45 days, the centre is significantly superior to the periphery in the production of buds. During the second observation at 150 days, the differences between the two positions are narrowed down; however, the centre kept its numerical superiority over the periphery.

DISCUSSION

The experiment lends support to the customary practice of applying caustic soda or lime wash to the pruned frame-work of tea bushes. It is shown that a careful application of 2% caustic soda solution is beneficial and that lime wash is almost as good as caustic soda solution though not superior to it. This finding is at variance with that of Portsmouth (1952) who reported that lime wash was superior to caustic soda. Both lime wash and caustic soda wash have resulted in the production of more number of buds than the other treatments. As it is difficult to handle caustic soda solution and as excessive application may result in scorching and killing of the bark tissues, it is suggested that lime wash could be employed as an alternative. Lime wash gives a white-washing effect and this should also be helpful in preventing sun-scorch of the bark tissues of the frame. With the modern methods of high pruning leaving several tender branches, and at times leaves also, lime wash is preferable to caustic soda solution, but as Rose (1953) mentions a good quality lime is necessary for this purpose.

It is also observed in this experiment that the central branches put forth buds quicker than the peripheral branches, although as time advances, the differences in the number of buds developing on the central and peripheral branches are not statistically significant. However, it must be mentioned that the number of buds produced on branches in the centre of the bush is numerically superior to that produced in the peripheral branches. This observation is in agreement with the finding of de Haan (1949) that the centre of the bush is more productive than the periphery.

SUMMARY

This paper presents the results of an experiment on the effect of the position of the branches and the treatments they have received on bud-break in pruned tea bushes.

Bud-break was quicker in the branches in the centre of the bush than in the periphery, but as time advanced, the differences were narrowed down.

Caustic soda solution (2%) produced significantly greater number of buds than the other treatments. With reference to the central position, application of caustic soda solution (2%) and lime wash (10% suspension in water) have contributed to significant increase in the number of buds developing on the branches. Although caustic soda solution appeared to be slightly better than lime wash in this experiment, in view of the risk involved in its use, it is suggested that lime wash could be preferred to caustic wash.

ACKNOWLEDGEMENT

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REFERENCES

1. de Haan, I (1949) De physiologie der bladvorming bij thee. *Arch. Theecult.* 16 : 83 - 125.
2. de Jong, P. (1951) The removal of mosses and lichens from pruned tea. *Plant. Chron.* 46 : 312 - 14.
3. Portsmouth, G. B. (1952) Report of the Plant Physiologist for the year 1950. *Tea Res. Inst. Ceylon, Bull.* 32 : 36 - 40.
4. Rose, E. S. (1953) A note on lime washing. *Tea Quart.* 24 : 94 - 96.
5. Venkataramani K. S. (1951) Report of the Botanist. A. R. UPASI Tea sci. Dep. for 1950-1951, pp. 22 - 27.

ROOTING OF TEA CUTTINGS AS AFFECTED BY SOME CHEMICAL TREATMENTS

K. S. Venkataramani

It is recognised that rooting of tea cuttings is governed by several factors (1, 2, 5, 6). Growth substances (hormones) are known to influence rooting at least in some clones and under certain circumstances (5, 8). In May 1960 experiments were commenced to determine the effect of indolebutyric acid (IBA) and gibberellic acid (GA) in a powder form, china clay which is generally used as a diluent in powder formulations of hormonal dusts, sucrose, and two proprietary fungicides, Agrimycin and Captan – all these separately and in combination with each other. The results of these experiments are presented in this communication.

MATERIALS AND METHODS

The standard technique of rooting 'leaf and internode' cuttings was followed and green-wood cuttings from two clones 'BBRB' and 'DRB' were employed. The rooting medium was a sandy loam with a pH value of 5.2. Small earthenware pots, open at both ends and filled with the rooting medium, were used as containers and one cutting was planted in each pot. This procedure enabled careful removal of the medium and examination of the cutting for rooting at periodical intervals. The pots were kept under the shade of woven coir-matting (6 mm. mesh) provided at a height of 75 cm. At the end of 16 weeks the experiments were terminated and the dry weight of roots of cuttings under each treatment was determined.

The treatments given to cuttings are mentioned in tables 1 and 2.

TABLE I

Details of dust formulations locally made and employed in the trials

Treat- ment.	IBA	China clay (in g. per 5 g. of the formulation)	Sucrose	Captan*	Agrimycin**	Gibberellic acid
A	0.05	4.95	—	—	—	—
B	0.05	4.45	0.50	—	—	—
C	0.05	4.20	0.50	0.25	—	—
D	0.05	4.20	0.50	—	0.25	—
E	—	4.75	—	0.25	—	—
F	—	4.75	—	—	0.25	—

Treat- ment.	IBA	China clay (in g. per 5 g. of the	Sucrose	Captan* formulation)	Agrimycin**	Gibberellic acid
G	—	5.00	—	—	—	—
H	—	—	—	5.00	—	—
I	—	—	—	—	5.00	—
K	—	4.50	0.50	—	—	—
L	—	4.25	0.50	0.25	—	—
M	—	4.25	0.50	—	0.25	—
N	0.05	4.70	—	0.25	—	—
O	0.05	4.70	—	—	0.25	—
S	—	4.95	—	—	—	0.05
T	—	4.45	0.50	—	—	0.05

* Flit 406 (50% Orthocide).

** Containing 35.3% copper, 3% streptomycin
and 0.3% Oxytetracycline.

TABLE 2

Details of liquid formulations

<i>Treatment.</i>	<i>Formulation.</i>
P	— 5000 p.p.m. of IBA in 50% alcoholic solution.
Q	— 20% sucrose in 50% alcoholic solution containing liquid Tillex (0.1 ml. in 100 ml. of the solution).
R	— Same as 'Q', but with addition of 5000 p.p.m. of IBA.
U	— GA 10 p.p.m. aqueous solution — 1 ml. sprayed per mother leaf; once at the time of planting and again 4 weeks later.

Cuttings were dipped in the powder formulations to a depth of about 3 mm. and the treated cuttings were immediately inserted in the rooting medium. Similarly the basal 3 mm. length of the cutting was immersed in the liquid formulations for 3 to 5 seconds before the cuttings were put out for rooting.

EXPERIMENTAL RESULTS

The results are presented in tables 3 and 4.

TABLE 3

Effect of treatment on rooting of cuttings in clone 'BBRB'

Treatment	No. of cuttings (out of 6) rooted after			Dry weight of roots of 6 cuttings (mg.)
	8	12	16 weeks	
A	1	3	6	2280
B	1	4	6	2478
C	0	4	6	2282
D	0	4	6	2244
E	0	3	6	1290
F	0	3	6	1236
G	0	2	6	1224
H	0	3	6	1468
I	0	2	6	1216
K	0	4	6	1980
L	0	3	6	2094
M	0	3	6	2076
N	0	2	6	2262
O	0	4	6	1938
P	1	4	6	2412
Q	2	4	6	2352
R	2	5	6	2544
S	0	2	6	1233
T	0	4	6	1898
U	0	3	6	1212
Control	0	2	6	1218

Treatment with IBA, either alone or in combination with sucrose, resulted in early initiation of roots and the root system formed in such treated cuttings was heavier than in the untreated controls. GA has had no effect on rooting, but there were indications of acceleration of the growth of the axillary buds. Captan and Agrimycin, which were included in the dust formulations to prevent bacterial attack, did not appear to exert any beneficial effect on rooting of cuttings.

TABLE 4

Effect of treatment on rooting of cuttings of clone 'DRB'

Treatment	No. of cuttings (out of 20) rooted after			Dry weight of roots of 10 cuttings (mg.)
	8	12	16 weeks	
A	0	16	18	3490
C	0	12	17	4043
D	0	10	19	3008
Q	0	12	18	3415
R	0	14	18	3932
U	0	7	17	
Control	1	8	16	2016

Here again, treatment with IBA, both in powder form and in concentrated alcoholic solution, with and without sucrose, helped in earlier and heavier rooting than in the untreated control. Sucrose alone was also effective in inducing good rooting. GA once again did not show any beneficial effect on rooting; it, however, prevented prolonged dormancy of the axillary bud.

DISCUSSION

These experiments confirm the earlier findings (4, 7) that treatment of tea cuttings with IBA results in quicker and heavier rooting, although the percentage rooting is not materially influenced. Treatment with sucrose alone has also shown beneficial effect indicating the necessity for adequate carbohydrate reserves in cuttings for satisfactory rooting. Agrimycin, either alone or diluted with china clay, had practically no effect on rooting. Captan appeared to exert some beneficial influence on rooting, but the effect was not of the same magnitude as that of IBA. In combination with IBA, they were superior to untreated controls, but rooting was better with IBA in the absence of these fungicides. In fact, when Agrimycin was used with IBA, it appeared to suppress root growth to some extent. Addition of sucrose to the mixture of IBA and Agrimycin seemed to counteract the suppressing effect of Agrimycin. In an earlier experiment (8), it was reported that treating the soil with Agrimycin and Captan was helpful in rooting tea cuttings. This, however, has not been the experience in the present investigation. Three possible reasons for this discrepancy are: (i) in the present investigation single clonal material was used as against a mixed population of cuttings from several clones in the earlier

experiment, (ii) the method of application of the fungicides itself was different in the two investigations, and (iii) in the earlier trial, the number of cuttings rooting in the untreated control was less than that in the treated series and as presumed by that author, it is likely that fungicidal treatment could have arrested fungal infection and thus helped in better rooting in the treated series; in the present trial, however, 100 per cent rooting was obtained even in the untreated control.

Gibberellic acid (GA) has had no effect on rooting and this is in agreement with previous findings (9). The axillary bud, however, seemed to have been stimulated by GA treatment, as the buds in these cuttings began to sprout earlier than in the other treatments, and this confirms our previous observations (3). It would appear, therefore, that GA could be used to break the dormancy of the axillary bud in rooted cuttings and this aspect of work merits further investigation.

SUMMARY

The effect of treating tea cuttings with indolebutyric acid (IBA), gibberellic acid (GA), sucrose and two fungicides was investigated with cuttings derived from two clones. Although IBA treatment did not result in a better percentage of rooting than in the untreated control, the root system was superior to that of the control. Sucrose also appeared to be beneficial. Gibberellic acid (GA) was not useful in rooting, but it seemed to be helpful in breaking the dormancy of the axillary bud. Two fungicides tried in this investigation did not materially influence the rooting of cuttings.

REFERENCES

- (1) Venkataramani, K.S. (1957) Some thoughts on vegetative propagation of tea. *UPASI sci. Dept., Tea Sect., Bull.* 17 : 37-41.
- (2) Venkataramani, K.S. (1958) Rooting responses of tea cuttings. *UPASI sci., Dep., Tea Sect., Bull.* 18 : 52-56.
- (3) Venkataramani, K.S. (1959) Report of the Botanist. *A. R. UPASI sci. Dep., Tea Sect., for 1958-1959*, pp. 15-16.
- (4) Venkataramani, K.S. (1960) The effect of growth substances on rooting of tea cuttings. *A. R. UPASI sci. Dep., Tea Sect., for 1959-1960*, pp. 49-58.
- (5) Venkataramani, K.S. (1961) Source of propagation material and its influence on rooting of tea cuttings (in press).

- | | |
|-------------------------|--|
| (6) Venkataramani, K.S. | (1961) Striking of tea cuttings as influenced by the rooting medium (in press). |
| (7) Venkataramani, K.S. | (1961) Rooting of tea cuttings as influenced by treatment with indolebutyric acid (in press). |
| (8) Venkata Ram, C.S. | (1960) Fungi causing stalk-rot and failure of tea cuttings in vegetative propagation nursery beds and their control. <i>A. R. UPASI sci. Dep., Tea Sect., for 1959-1960</i> , pp. 59-62. |
| (9) Visser, T. | (1958) Report of the Plant Physiologist for the year 1957. <i>Tea Res. Inst., Ceylon, Bull.</i> 39: 39-46. |

STRIKING OF TEA CUTTINGS AS INFLUENCED BY THE ROOTING MEDIUM

K. S. Venkataramani

The rooting of 'leaf and 'internode' cuttings of the tea plant (*Camellia sinensis* (L.) O. Kuntze) depends on several factors (2, 3). Of late, stress is laid on the acidity of the rooting medium as one of the most important amongst the external conditions governing successful rooting of tea cuttings. Vissar *et al* (5) mention that the optimal pH for rooting may be in the neighbourhood of 4.5 or even somewhat lower, while still recognizing that a soil with a good 'structure' and a pH above 5.0 may be more suitable than a poor soil with a pH value nearer the so-called optimum. Different soils and soil mixtures were tried by them and soil cropped with Guatemala grass (*Tripsacum laxum* Nash.) was found to give the best results.

Although our experience in South India has also been that tea cuttings favour an acidic rooting medium and that a pH value of below 5.0 generally gives good results, recent experiments have shown that rooting appears to be more influenced by the texture of the medium than by the actual pH value, provided the reaction is fairly acidic. A brief account of one of our experiments is presented here, as it is of some interest.

Two kinds of rooting media were employed: (i) soil taken from the top six inches of an area where Guatemala grass was grown for four years, and (ii) a sand-soil mixture (1: 3 by weight), the soil having been taken from a non-cropping land adjacent to a tea field. The mechanical analysis of these two media was as follows:-

	Guatemala grass soil	Sand-soil mixture
Coarse and	34.3%	49.9%
Fine sand	25.8%	20.8%
Silt	10.2%	9.0%
Clay	30.8%	20.5%
Organic matter (C x 1.72)	2.6%	1.8%
pH	5.19	5.92

The pH of these media were altered to a more acidic side by the addition of dilute sulphuric acid and the treated soils were used in the nursery three weeks later. Cuttings from a good rooting clone 'BBRB' were employed, 25 cuttings per treatment. Standard methods of rooting tea cuttings were followed (1, 4, 6). The results obtained 12 weeks after the commencement of the experiment are presented in the following table:

Rooting medium	pH	No of cuttings		Total No. of roots in rooted cuttings	No. of roots per rooted cutting	Total length of roots in mm.	Root length per cutting in mm.
		Callused	Rooted				
1. G. grass soil	5.19	16	9	27	3	429	47.6
2. G. grass soil	4.39	11	14	98	7	1011	72.2
3. Sand-soil mixt.	5.92	15	10	60	6	480	48.0
4. Sand-soil mixt.	5.12	8	17	187	11	1633	97.7

In both rooting media, a lower pH value was more conducive to better rooting of the cuttings. One point of special interest that has emerged out of this experiment, and which is well worth pursuing further, is that in an open soil, such as a sand-soil mixture, tea cuttings may tolerate a slightly higher pH value than what is usually considered as optimum. In fact, the root system was better (both in number and length of roots) in the sand-soil mixture (medium 4) than in the grass soil with a much lower pH value (medium 2). At comparable pH values (media 1 and 4), the sand-soil mixture was superior to the grass soil.

The question now arises as to whether or not these results can be interpreted mainly in terms of pH or whether perhaps some other factors interacting with pH are involved. A direct interaction might occur, for example, if acidification of the rooting medium resulted in an alteration in its structure, which influences its air/moisture ratio, but in this experiment mechanical analysis of the media before and after acidification showed no difference. Acidification could also presumably alter the available nutrient status of a medium containing soil. We, however, have no information on this aspect and this has to be considered. There may be interactions between pH and other environmental factors, such as temperature, light intensity, source and type of cutting. In this investigation, however, these latter factors have been identical for all treatments and are unlikely to have influenced the results. As has been mentioned already, rooting of tea cuttings is more influenced by the texture of the medium than by its pH value, but with the same medium, rooting appears to be better at a lower pH value. This would indicate that each soil medium may have its own optimum pH range for successful rooting. This aspect of vegetative propagation of tea certainly deserves extended study.

I am thankful to my colleague Mr. V. Jayaraman for the analysis of the rooting media and to Mr. G. K. Argles, Director of the Commonwealth Bureau of Horticulture and Plantation Crops, England for helpful criticism of the data presented in this paper.

REFERENCES

- (1) Eden, T., and Bond, J. (1941) The technique of vegetative propagation of tea. *Tea Quart.* 14 : 102-105.
- (2) Venkataramani, K.S. (1957) Some thoughts on the vegetative propagation of tea. *UPASI sci. Dep., Tea Sect. Bull.* 17 : 37-41.
- (3) Venkataramani, K.S. (1958) Rooting responses of tea cuttings. *UPASI sci. Dep., Tea Sect., Bull.* 18 : 52-56.
- (4) Venkataramani, K.S. (1960) Report of the Botanist. A. R. *UPASI sci. Dep., Tea Sect., for 1959-1960*, p. 16.
- (5) Visser T., Kehl, F.H., (1959) Propagation of tea cuttings. I. Soil and
and de Was Tillekeratne, nutrient requirements. *Tea Res. Inst. Ceylon,*
L.M. *Bull.* 1 (n.s.) : 1-15.
- (6) Wight, W. (1955) Commercial propagation of *Camellia sinensis*
in India. *Amer. Camellia Soc. Yearb.* 1955 :
88-100.

ROOTING OF TEA CUTTINGS AS INFLUENCED BY TREATMENT WITH INDOLEBUTYRIC ACID

K. S. Venkataramani

Growth substances have been tried in vegetative propagation of the tea bush [*Camellia sinensis* (L.) O. Kuntze] in all tea research centres, but so far no general recommendation has been made for their use in rooting tea cuttings. Results reported hitherto are conflicting, as could be seen from a recent review on the subject (6). Current work in South India shows promise and a brief account of some of our experiments is presented here.

A standard technique of vegetative propagation of tea with 'leaf and internode' cuttings (2, 7) was followed throughout. Quick-dip method with a 50% alcoholic solution of indol-3-butyric acid (IBA) at a concentration of 5000 p. p. m. was adopted, and 3 to 5 mm. of the basal ends of the cuttings were immersed in this solution for 2 to 3 seconds before insertion into the rooting medium, which was a sandy loam with a pH value of 5.4. Small earthenware pots, open at both ends, and filled with this medium were used as containers and one cutting was planted in each pot. This procedure enabled careful removal of the medium and examination of the cuttings for rooting at periodic intervals. Cuttings from two clones, 'DRB' and 'B2', were employed in these experiments. In clone 'DRB', 40 cuttings were available for each treatment and in clone 'B2', 50 cuttings. The pots were kept under the shade of woven coir-matting (6 mm. mesh). The results of these trials are summarised in Fig. 1 and Table 1.

In both clones, a greater number of cuttings treated with IBA rooted earlier than in the untreated series. For instance, during a period of 10 weeks, 60 per cent. of the treated cuttings rooted, whereas in the untreated control roots were formed in only 28 per cent. of the cuttings in clone 'B2'. Similarly in clone 'DRB', 75 per cent. of the treated cuttings rooted in 12 weeks, as against only 35 per cent. in the control (Fig. 1). Quantitative data obtained in one of the experiments are presented in Table 1.

TABLE 1

Showing the effect of treating cuttings of clone 'DRB' with IBA.

	Control series	IBA series
1. Percentage of cuttings rooting in 13 weeks	37.5	52.5
2. Total number of roots in 15 cuttings	95	270
3. Number of roots per cutting	6	18
4. Total length of roots in 15 cuttings (mm)	599	3279
5. Average length of roots per cutting (mm)	39.9	218.6
6. Average length of a root (mm)	6.3	12.1
7. Total dry weight of roots from 15 cuttings (mg.)	48	210
8. Average dry weight of roots per cutting (mg.)	3.2	14.0

Fig. 1.

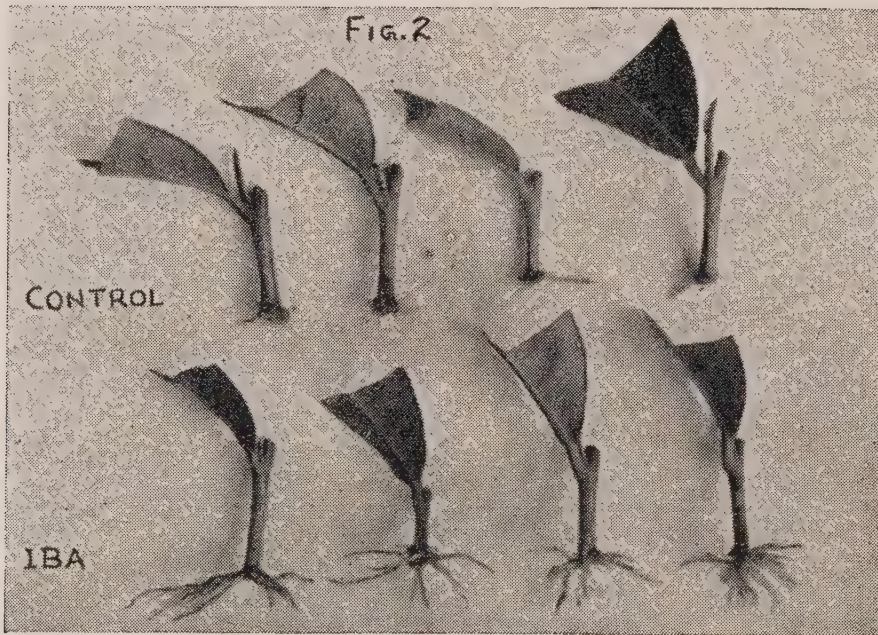
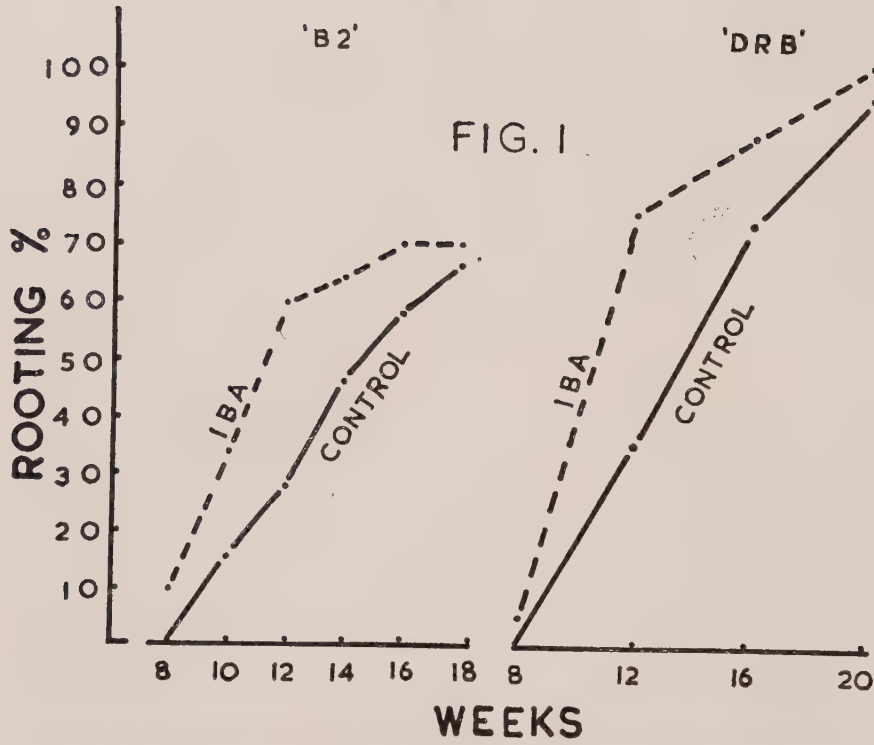


Fig. 2. Showing the root systems of treated and untreated cuttings.

The number of roots formed in the treated cuttings was thrice that developed in the untreated ones. Similarly, in length and dry weight of roots, treatment with IBA has had a positive response. Figure 2 shows the root systems of treated and untreated cuttings.

It is realised that different tea clones may react differently to treatment with growth substances and that such a treatment may not materially influence the ultimate percentage of rooted cuttings after a prolonged period in the nursery (5). In the experiments reported here (Fig. 1), the cuttings in the untreated control series rooted almost to the same extent as in the treated series at the end of 18 and 20 weeks, in both clones, but it must be noted that IBA treatment speeded up rooting and a large number of rooted cuttings could be lifted from the nursery in a short time. Similar observations have been made by Eden (1) and van Emden (3, 4). Early rooting, by itself, is desirable. Coupled with a heavy root system, which would enable easy transplantation, the advantage of early rooting becomes obvious. General observations on an estate, where tea cuttings are treated with IBA as a routine measure, reveal that it is useful.

The results reported here were obtained with two clones which root easily. Further investigation with different clones and growth substances is in progress and the results will be published in due course. If treatment with a suitable growth substance should prove beneficial in general, the quick-dip method, which is both easy and practicable, could then be adopted as a routine practice in estate nurseries.

REFERENCES

- (1) Eden, T. (1941) Report of the Plant Physiologist for 1940. *Tea Res. Inst. Ceylon, Bull.* 22 : 63-72.
- (2) Eden, T., and Bond, J. (1941) The technique of vegetative propagation of tea. *Tea Quart.*, 14 : 102-105.
- (3) van Emden, J. H. (1941) Mededeelingen inzake het stekken van thee. *Arch. Theecult.*, 15 : 33-45.
- (4) van Emden, J. H. (1950) Over de vegetative vermeerdering van de thee plant. *Arch. Theecult.*, 17 : 113-41.
- (5) Venkataramani, K. S. (1957) Some thoughts on vegetative propagation of tea. *UPASI sci. Dep. Tea Sect., Bull.* 17 : 40.
- (6) Venkataramani, K. S. (1960) The effect of growth substances on rooting of tea cuttings. *A. R. UPASI sci. Dep., Tea Sect., for 1959-1960* : 49-58.
- (7) Wight, W. (1955) Commercial propagation of *Camellia sinensis* in India. *Amer. Camellia Soc. Yearb.* 1955 : 88-100.

REDUCED LIGHT INTENSITY AND GROWTH OF YOUNG CLONAL TEA PLANTS—A PRELIMINARY NOTE

K. S. Venkataramani

The question of shade for tea — in fact, for all the three major beverage crops, namely tea, coffee and cocoa — has received considerable attention from scientists as well as planters. There are reasoned views both for and against the conventional method of planting these perennial plantation crops under the shade of trees. As far as tea is concerned, extensive work has been done in Assam and in recent years attention has been focussed on this subject in Nysaland, Indonesia and Ceylon. This subject has been discussed already at great length by other writers (2,8,9) and it is beyond the scope of this article to review the work done. In brief, it may be mentioned that shade is favoured for tea in Assam, while in Indonesia removal of shade trees is suggested. The present tendency, however, is to advocate growing these tropical plantation crops in fully exposed conditions, as they seem to respond better to manuring under such conditions than under shade, provided other conditions are conducive to such a treatment of the crop (1, 5, 6, 8). Nevertheless, it should be realised that young and old plants may have different light requirements and this is well known in the case of cocoa (4). As information on this subject with reference to tea in southern India was not available, a preliminary trial was undertaken with young clonal plants and the results are presented in this article.

Uniform one year old plants of clone B-34, set in earthenware pots, were chosen for the experiment. The pots were of uniform size, each taking 9 kg. of a sandy loam soil. The plants were centered to four leaves. Six plants were kept under open conditions, fully exposed to the sun, and six others under the shade of woven coir-matting allowing approximately 60 per cent of the light intensity in the open. Watering was done as and when necessary and all plants received the same amount of a fertiliser mixture at the start of the experiment on December 5, 1960. The observations made on March 25, 1961 are summarised in the following table:

	Data for 6 plants in		Diff. reqd. for significance at P: 0.01
	Sun	Shade	
1. Dry weight of the first internodal stem (mg.)	3263	4197	441
2. Dry weight of old stem (mg.)	5929	7741	1736
3. Dry weight of stems developed after centering (mg.)	6701	10635	2917
4. Dry weight of leaves (mg.)	12134	24009	1699
5. Total dry wt. of aerial portion (mg.)	28027	46582	—
6. Dry weight of roots (mg.)	19385	20660	—
7. Top/Root ratio	1.445	2.254	—
8. Total length of new stems (cm.)	264.8	380.1	—
9. Total number of leaves	122	174	38
10. Total leaf area (sq. cm.)	1647	4206	885

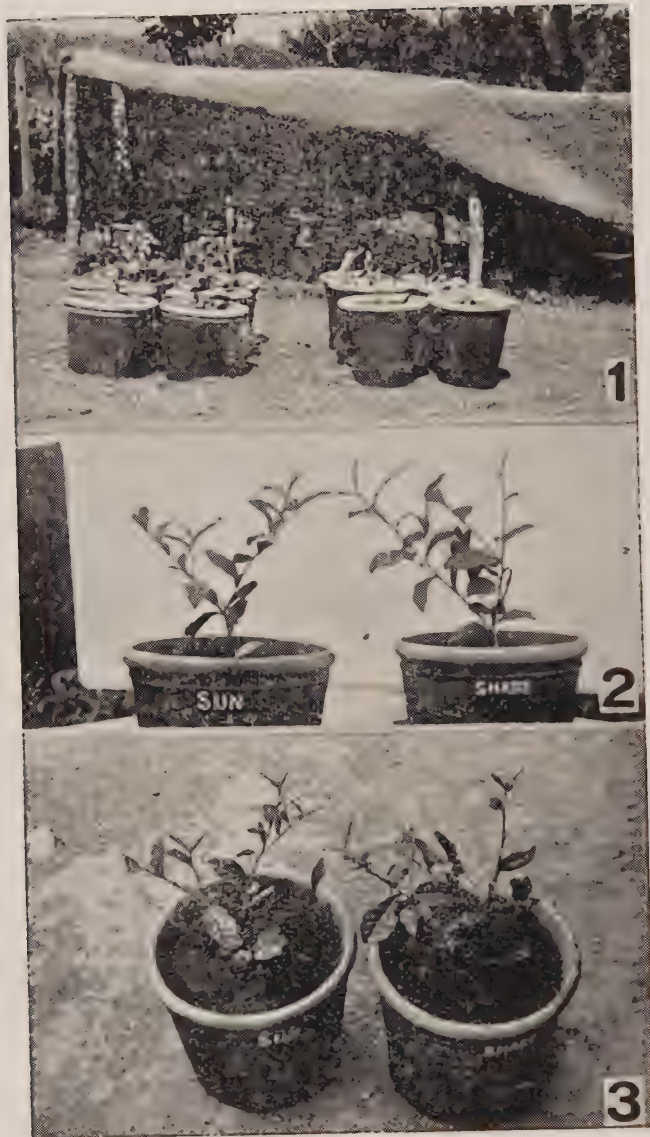


Fig. 1 shows the set up of the experiment. The plants in the foreground are in full sun, and those in the back are under shade.

Fig. 2 and 3 Note the better growth of the shaded plants.

It is evident from these results that young tea plants benefit by reduced light intensity (Figs. 1, 2 & 3). The dry weights of first internode stem, old stem, newly developed stems and leaves were all significantly greater in plants under shade than those in exposed plants. The shaded plants produced more number of leaves than those in full sun and the total leaf area was also greater in them (The actual leaf area was determined by multiplying the product of length and greatest width by a factor 0.71; this factor is constant for the clone under discussion, but it varies with different clones).

Examination of the leaves at different periods of the day also showed that in the shaded plants the stomata were open for a greater part of the day than in those in full sun. In fact, in the leaves exposed to sun, the stomata were practically closed between mid-day and 3 p.m. Test for total chlorophyll also indicated that the leaves of the shaded plants were richer in chlorophyll per unit weight of dry leaf than those of the plants kept in the open, and this is in agreement with the previous finding in tea in Ceylon (7) and in cocoa in the West Indies (3).

It would appear, therefore, that young tea plants do require some shade. Further critical experiments with different light intensities, of course, are necessary to determine the optimum light intensity required for the best growth of young tea plants.

REFERENCES

- | | |
|--|--|
| (1) Cunningham, R.K., and Burridge, J.C. | (1960) The growth of cacao (<i>Theobroma cacao</i>) with and without shade. <i>Ann. Bot. (n.s.)</i> 24: 458-62. |
| (2) De Weille, G.H. | (1959) The adaptation of tea cultivation to the occurrence of blister blight. <i>Arch. Tea Cult.</i> , 20: 161-92. |
| (3) Evans, H., and Murray, D.B. | (1951) A shade and fertiliser experiment on young cacao. <i>Rep. Cocoa Res. 1945-1951, I.C.T.A., Trinidad</i> , pp. 1-10. |
| (4) Himme, M. van and Petit, J. | (1957) First results of an experiment on artificial shade for cocoa trees at Yangambi. <i>Rep. Cocoa Conf., Lond. 1957</i> , pp. 227-41. |
| (5) Murray, D.B. | (1955) Climatic requirements of cocoa with particular reference to shade. <i>Rep. Cocoa Conf., Lond., 1955</i> , pp. 17-22. |
| (6) Poncin, L. and de Bellefroid, V. | (1957) The use of shade at Lukolela plantations. <i>Rep. Cocoa Conf. Lond., 1957</i> , pp. 281-88. |
| (7) Ramaswamy, M.S. | (1960) Report on Biochemistry for 1959. <i>A. R. Ceylon Tea Res. Inst. for 1959</i> , p. 49. |
| (8) Visser, T. | (1961) Interplanting of tea. Parts I and II (in press). |
| (9) Wight, W. | (1958) The shade tree tradition in tea gardens of Northern India. Parts I, II and III. <i>A. R. Tocklai exp. Sta., Indian Tea Assn. for 1958</i> , pp. 75-150. |

EFFECT OF ALUMINIUM SULPHATE AND SOME SEQUESTRENE COMPOUNDS ON THE GROWTH OF YOUNG TEA PLANTS

K. S. Venkataramani

This article presents an account of the effect of soil application of aluminium sulphate and some Sequestrene metal chelates on the growth of rooted tea cuttings.

Thirty uniform rooted cuttings of clone 'B-34' were chosen for this experiment (size of axillary bud 5 mm., and length of roots about 15 mm.). The cuttings were carefully lifted from the nursery bed and transplanted into small tubular earthenware pots, each taking 1 kg. of air-dry soil. The pots were kept under the shade of woven coir-matting allowing approximately 60% of the light intensity in the open. After establishing, they were divided into six lots of five plants each and the following treatments were given on the 6th December 1960:

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|--------------------------------|---|--|
| 1. Untreated control | } | 2 g. applied per pot as a dilute solution on the soil surface. |
| 2. Sequestrene Iron Chelate | | |
| 3. Sequestrene Zinc Chelate | | |
| 4. Sequestrene Copper Chelate | | |
| 5. Sequestrene Calcium Chelate | | |
| 6. Aluminium sulphate | | |

The pots were watered as usual, as and when necessary, without leaching. By early March 1961, visual differences were noticed in the treated plants. The experiment was terminated on the 11th March 1961 and the observations made are summarised in the following table:

Treatments	For 5 plants		
	Shoot length (mm)	No. of lateral roots > 2 mm. in dia.	Dry weight of roots (mg).
Control (untreated)	103	11	1905
Sequestrene Iron	105	11	1832
Sequestrene Zinc	104	0	1850
Sequestrene Copper	97	3	1899
Sequestrene Calcium	94	0	953
Aluminium sulphate	135	17	3792
Difference required for significance at P : 0.01	14.5	4.4	148

Sequestrene compounds of iron and zinc had no effect on the plants, except that in the case of zinc none of the lateral roots was greater than 2 mm. in diameter. The shoot length was adversely affected in the case of calcium and copper treatments, but the differences were not significant. Thick lateral roots were significantly less in number in the copper treatment. The calcium treatment definitely inhibited root growth, as evidenced by the poor dry weight of roots. In fact, the root-tips were discoloured and death of some of the roots was noticed. The aluminium sulphate treatment had a marked beneficial effect on the growth of the shoot as well as the roots. A large number of lateral roots was thicker and the dry weight of roots was very nearly twice that of the control.

The initial pH value of the soil employed in this experiment was 5.72 and the treatments did alter it. In the case of the calcium treatment, the pH value at the end of the experiment was 6.40, while the pH values, were 5.68, 5.61 and 5.52 respectively for the iron, copper and aluminium treatments. Whether these slight changes were directly responsible for the differences in growth of the plants it is difficult to say, but it is recognized that tea cuttings do favour a fairly acid soil. Low acidity bordering on neutrality and lime application are also known to affect the growth of young tea plants adversely (2). The role of aluminium in the growth of tea plants has been well discussed by Chenery (1) and our present observations support his findings. The development of a large number of thick lateral roots in the aluminium sulphate treated series is a distinct advantage to plants raised through cuttings, and it is worth pursuing this aspect further to find the possibilities of the practical application of this in large scale vegetative propagation of tea.

I am thankful to Messrs. Tata-Fison Private Limited for the samples of Sequestrene metal chelates employed in this investigation.

REFERENCES

- | | |
|--------------------|--|
| (1) Chenery, E. M. | (1955) A preliminary study of aluminium and the tea bush. <i>Plant and Soil</i> , 6 : 174-200. |
| (2) Jayaraman, V. | (1944) Soil pH as a factor in the growth of tea supply plants. <i>Plant. Chron.</i> , 39 : 171-76. |

EFFECT OF SOME INSECTICIDE AND HORMONE TREATMENTS ON THE GROWTH OF TEA SEEDLINGS

K. S. Venkataramani

It is not an unusual practice to treat the germinating and nursery beds with some insecticides to prevent ant and other insect damage, but injudicious use of some chemicals may prove lethal to germinating tea seeds. This has been well illustrated by Ananda Rau (2) with respect to the use of Agrocide in tea nurseries. At times, however, it becomes obligatory to treat the nursery soil to prevent damage to young seedlings. In general, the use of 5% BHC and some of the modern insecticides such as Aldrex and Dieldrex is suggested, but it is not clearly known what effect they may have on the growth of tea seedlings. Exploratory laboratory trials were undertaken with 5% BHC, Aldrex and Dieldrex, and this opportunity was availed of also to determine what effect treatment with a growth regulator such as indolebutyric acid (IBA) has on germinating tea seed.

Uniform sized tea seeds obtained from a polyclonal seed garden were employed in these trials. They were first allowed to germinate on moist sand. When the shell had cracked and the protruding radicle was about 2 mm. in length the germinated seeds were taken for the experiments.

In one experiment, small earthenware pots filled with soil treated with a 5% BHC dust (0.65% *gamma* isomer) at the rates of 0.5, 1.0 and 1.5g. per kg. of soil, were employed as containers for growing the seedlings, and a set of untreated controls was maintained as a check. For each treatment, ten seedlings were used. Examination of the seedlings at the end of two months showed that in all the BHC treated series the seedlings were poor both in shoot and root growth. The controls were far superior to the plants in the treated series (Fig. 2). In the treated series, the tender radicle of the germinated seed became clubbed and woody at the tip and ceased to grow any further; the effect was more pronounced at the higher rates of application of the 5% BHC dust, and development of the lateral roots was not noticed in any of these plants. Such clubbing or malformation of tea root has been reported also in other crops treated with this insecticide (1,3 and 4). One feature, hitherto ignored, is that injudicious use of a formulation containing even a low concentration of BHC, such as a 5% BHC dust, may cause considerable damage in a tea seed nursery.

In a second trial, the germinated seeds were transplanted into soil taken in small plastic tumblers and the soil surface was wetted lightly with a dilute solution of Aldrex 24% E.C., and Dieldrex 15% E.C. (dilution 1 in 500). Two months later, the seedlings were carefully lifted from the soil and examined with the following results:



Fig. 1 shows the effect of treating germinating tea seeds with IBA. A; Control (untreated)

B, C, D and E: seeds treated respectively with 50, 500, 1000 and 5000 p p m of IBA.

Fig. 2 shows the effect of BHC on tea seedling. A: Control. B, C, D: 0.5, 1 0 and 1.5 gr. of 5: BHC in 1 Kg of soil respectively.

E: enlarged view of D.

Treatments	Average shoot length (mm.)	Average length of tap-root (mm.)	Dry wt. of shoots (g.) of 5 plants	Dry wt. of roots (g.) of 5 plants
Control	145	98	0.908	0.515
Aldrex 24 EC	151	102	0.910	0.525
Dieldrex 15 EC	140	100	0.898	0.513

There was practically no difference in the growth of tea seedlings in the control and the treated series.

In a third experiment, the germinated seeds were dipped for ten seconds in 50% ethyl alcohol and in solutions of IBA in 50% alcohol (50, 100, 500, 1000 and 5000 p.p.m.) prior to sowing in soil in plastic tumblers. Each treatment was replicated ten times and a similar set of untreated controls was maintained as a check. The seedlings were examined six weeks after treatment and the results are presented in the following table:

Treatment	Average shoot length (mm.)	Average length of tap-root (mm.)	Dry Wt. of shoots (g.) of 10 plants	Dry Wt. of roots (g.) of 10 plants
Untreated control	152	113	1.646	0.693
Control (50% alc.)	154	108	1.628	0.702
50 p.p.m. IBA	152	107	1.335	1.004
100 " "	149	*	1.281	0.901
500 " "	98	*	1.302	0.673
1000 " "	93	*	0.913	0.594
5000 " "	87	*	0.697	0.682

*There was no distinct tap-root

It would appear from these results that there was no special advantage gained by the use of IBA. At and above 100 p.p.m., IBA had an adverse effect on the growth of the tap-root. In the 50 and 100 p.p.m. IBA treatments, the dry weight of roots was more than that of the control series and this was due to greater number of lateral roots developing on the treated plants. In general, shoot growth was also adversely affected at all concentrations of IBA, as evidenced by the poor shoot length and dry weight of the aerial portion. That high concentrations of IBA cause death of tap-root and induce profuse branched root formation may be clearly noticed in Fig. 1.

In short, these exploratory trials have shown that even a 5% BHC dust can cause damage to germinating tea seeds and that judicious use of Aldrex and Dieldrex may be helpful in controlling soil pests in nurseries. Treatment of sprouted seed with IBA is of no special advantage; on the other hand, its careless use may result in damage to tea seedlings.

REFERENCES

- | | |
|--|--|
| (1) Agarwala, S.B.D. | (1953) Effect of benzene hexachloride on growth of sugarcane. <i>Curr. Sci.</i> , 22 : 19-20 |
| (2) Ananda Rau, S. | (1953) Report of the Asst. Scientific Officer and Entomologist. A. R. UPASI sci. Dep. (Tea Sect.) for 1952-1953, p. 19. |
| (3) Ashby, D.G. | (1950) The phytotoxic effects of D.D.T., B.H.C., parathion and toxaphene on tobacco. <i>Ann. appl. Biol.</i> , 37 : 624-39. |
| (4) Simkover, H.G. and
Shenefelt, R. D. | (1952) Phytotoxicity of some insecticides to coniferous seedlings with particular reference to benzene hexachloride. <i>J. econ. Ent.</i> , 45: 11-15. |

SENSITIVITY OF TEA SEEDLINGS TO SOME TRIAZINE WEEDKILLERS

K. S. Venkataramani

In agricultural and horticultural crops chemical weed control is fast gaining importance. Several formulations have been and are being actively tested in coffee, rubber and tea plantations in almost all countries where these crops are commercially grown. Simazine, one of the triazine weedkillers, is now being found useful for weed control on some tea estates in Ceylon, when employed at the rate of 2 to 6 lb. per acre (2.2 to 6.6 kg./hectare). Private information from North East India also suggests its potential use in tea fields. While we recognise that there may not be any serious hazard if it is judiciously used in mature tea fields, we have no information on the effect of this weedkiller on tea seedlings and young tea plants under our soil conditions. A preliminary pot trial was undertaken in April 1960 with two triazine weedkillers, Simazine and Atrazine, and the results are presented in this paper.

Pots of uniform size, taking 9 kg. of soil were selected as containers. The soil for the trial was taken from the top nine inches of land adjacent to a tea field and it analysed as follows:

Coarse sand	...	21.5 %
Fine sand	...	20.5 %
Silt	...	20.5 %
Clay	...	38.3 %
Organic matter (C x 1.72)		3.24 %
pH	...	5.57
True specific gravity	...	2.58
Apparent specific gravity		1.11

Appropriate quantities of 50% wettable powder formulations of Simazine and Atrazine were thoroughly mixed with the air-dry soil to give the following concentrations of the respective active ingredient: 1, 4, 16, 64 and 256 p.p.m. The pots were filled with such treated soil and for each concentration, five pots (replicates) were employed. Untreated soil was used for the controls.

Uniform sized (132 mm. initial height, from the cotyledonary node to base of apical bud) tea seedlings of Manipuri jat, each with three expanded leaves and a dormant bud, were used as test plants. The plants were carefully removed from the nursery baskets, their root system washed free of soil, and they were planted one in each pot. The pots were arranged in a random manner in the laboratory verandah and were watered as and when necessary taking care to prevent leaching

of water. Observations were made at weekly intervals on the growth of the tea plants. As phytotoxic symptoms were noticed in some treatments within two weeks, the experiment was terminated at the end of the first month and final observations were made on shoot and root growth and the results are given in table 1.

TABLE 1.

Effect of Atrazine and Simazine on young tea plants

Treatment	Average ht. in mm. from cotyledonary node to base of apical bud.	Average dry weight of root/seed- ling in mg.	Nature of apical bud.	Foliage.	Root System.
1. Control	157.0	61.5	Growing	Normal, healthy green-	Profuse laterals.
2. Atrazine 1 p.p.m.	155.8	59.2	Growing	As in Control.	As in Control.
3. Atrazine 4 p.p.m.	157.4	55.7	Growing	Slight yellowing.	Tipsof some laterals dead.
4. Atrazine 16 p.p.m.	143.0	37.2	Dormant	Necrosis seen on some leaves.	Laterals dying.
5. Atrazine 64 p.p.m.	136.2	19.5	Dormant	All leaves shedding	Laterals dying.
6. Atrazine 256 p.p.m.	134.2	10.5	Dormant	Leaf shed.	All laterals discoloured
7. Simazine 1 p.p.m.	156.6	62.2	Growing	Normal as in Control.	Same as in Control.
8. Simazine 4 p.p.m.	155.8	58.0	Growing	Slight yellowing in 2 plants.	Same as in Control.

Treatment	Average ht. in mm. from cotyledonary node to base of apical bud.	Average dry weight of root/seed- ling in mg.	Nature of apical bud.	Foliage.	Root System.
9. Simazine 16 p.p.m.	146.8	41.8	Growing	Distinct yellowing of leaves.	Some laterals dying.
10. Simazine 64 p.p.m.	137.00	23.2	Dormant	Leaves shed in 2 plants.	Some laterals dying.
11. Simazine 256 p.p.m.	135.4	17.8	Dormant	All leaves shed.	Many laterals dead and discoloured.
Difference required for significance at P=0.01	3.8				

It would appear from these results that young tea plants could tolerate Simazine upto about 4 p.p.m. of the active ingredient in the soil. Higher concentrations produced phytotoxic symptoms on the foliage (necrosis of the leaves). Above 4 p.p.m., the shoot growth was stunted and roots were also affected. In the case of Atrazine, even at 4 p.p.m., young lateral roots were damaged and at higher concentrations necrosis of leaves and death of roots was more pronounced than in Simazine treated series, and this formulation could do more damage to young tea plants than Simazine at equal rates of application.

In this experiment, the weedkillers were thoroughly mixed with the soil and the entire root system of the young plant was in intimate contact with the treated soil. This is a very drastic treatment and such a condition can seldom arise under field conditions, where the weedkiller is sprayed on the surface and allowed to leach into the soil. The usual recommendation of 2 to 6 lb. of Simazine 50 W.P. per acre (2.2 to 6.6 kg./hectare) of bearing tea field is within safe limits and could also probably be employed for use in nurseries and young clearings. It is proposed to carry out a further experiment under field conditions, and it is also desirable to study the effect of this promising weedkiller under different soil conditions.

I am thankful to Mr. Peter de Jong, Technical Manager of Messrs. Tata-Fison Limited, for the supply of the triazine formulations and to my colleague, Mr. V. Jayaraman, for the analysis of the soil.

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